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W. E. Batten, Head of ICI's Central Technical Information Unit, joined ICI at Billingham as a chemist in 1934. After a short spell in research, he moved to the Patent Department and became consequently associated with library and information problems. He transferred to Plastics Division in 1939 and was manager of the Patents and Intelligence Department until 1950 when he became responsible for co-ordinating the Division's effort on nylon as a non-fibre material. In 1953 Dr. Batten was made Head of the Division's Techno-Commercial Department and in 1963 he was appointed to his present post at Head Office.

Peter Bond recently took up a research fellowship in developmental genetics at the University of Sussex. He was previously with Pharmaceuticals Division, which he joined as a biochemist in 1959 on leaving Sheffield University. Dr. Bond's special interests include sport, natural history, pottery and photography.

Ian Brook, General Manager of ICI (Danmark), joined the Export Department of the then ICI Fibres Division from Cambridge in 1957. He was sent to Copenhagen in 1960 as the first 'Terylene' Marketing Officer for Scandinavia and was responsible for co-ordinating marketing and promotion for 'Terylene' not only in Denmark but also Norway, Sweden and Finland. In 1963 he was appointed to his present post as General Manager of ICI (Danmark). Outside work his interests include painting, fencing and, in summer, water-skiing.

J. A. (Alec) Cooper joined the Company from Bristol University in 1939 and, apart from a spell during the war in South Wales, his service has all been at Billingham, where he is now a member of the Project Design and Engineering Department. Dr. Cooper has been mostly concerned with the provision of factory services, and has been closely associated with the preparation of ICI's plans for increased water supplies from the Tees Valley and Cleveland Water Board's post-war reservoirs of Selset and Balderhead and currently from the proposed third new reservoir. He is a keen dinghy sailor and an enthusiastic supporter of the local sailing club.

Wilfred Duffy began writing in his early twenties and has since had articles and short stories published in more than a dozen national, county and trade publications. He has been connected with the brewing trade for the past nine years. Other special interests include art, reading and tape recording.

Harry Hutchison has been Nobel Division Publicity Officer since 1951 and Editor of *Nobel Times,* the Division newspaper, since its inception in 1955. He joined the Company in 1928 and worked for many years on the research side before moving over to publicity work in 1948. He writes occasionally for the Scottish press, mainly on country and historical subjects.

FRONT COVER: *Copenhagen, St. Nicholai's Church in the background*

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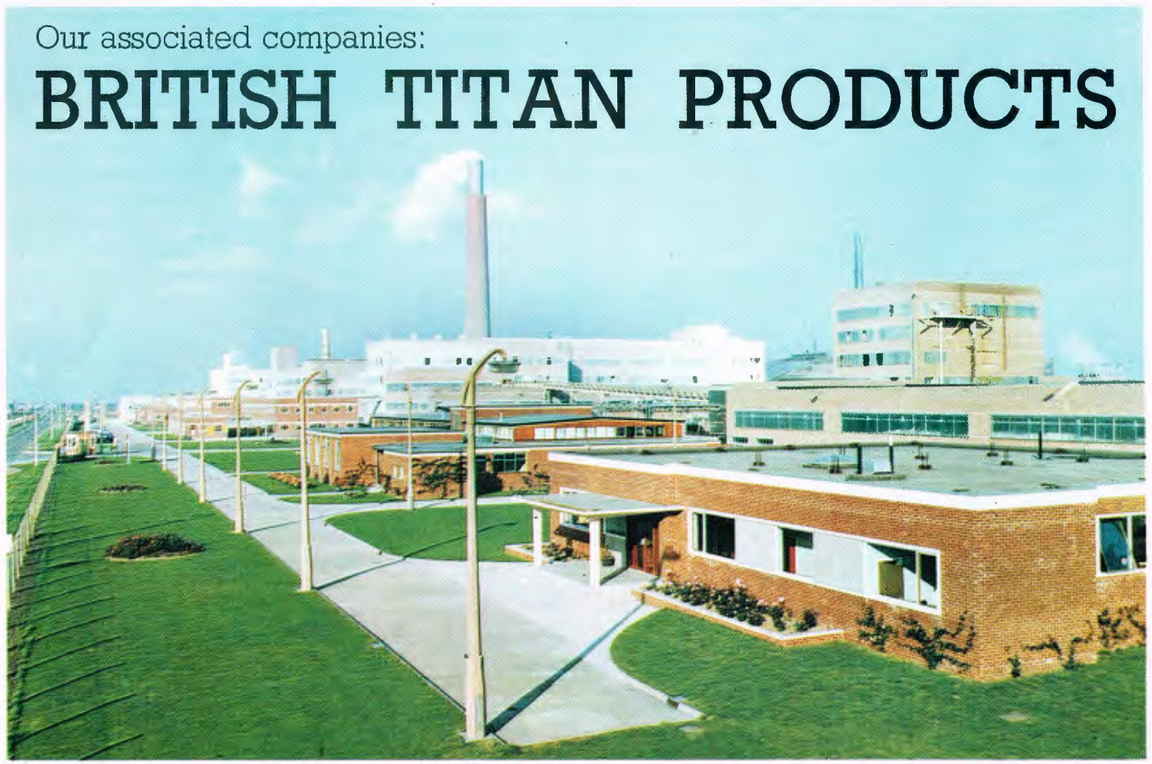
Our associated companies:

BRITISH TITAN PRODUCTS



The BTP factory at Grimsby

BRITISH Titan Products Company Limited, to use the full name—but almost everyone knows the company as BTP—came into being on 26th July 1930. It is therefore among the oldest of ICI's associated companies, being owned jointly by ICI, Goodlass Wall & Lead Industries Ltd., the Rio Tinto-Zinc Corporation Ltd. and R. W. Greeff & Co. Ltd. The company was formed to manufacture titanium dioxide, a white pigment which within a quarter of a century has virtually displaced all its competitors.

Manufacture of the pigment

By the so-called sulphate process, ilmenite, a black mineral that looks like crushed anthracite, is transformed into one of the whitest substances in the world. In this process the ore is dissolved in sulphuric acid and the titanium sulphate in solution is hydrolysed by steam to form a hydrated oxide. This is then calcined at a temperature in the neighbourhood of 1000°C and thereby converted into titanium dioxide. The sulphate approach to the manufacture of the pigment has been said to make use of every one of the processes of classical chemistry except distillation.

The new chloride process for making titanium dioxide is very different, and its raw material is mineral rutile, which varies in colour from sandy to almost black and will not dissolve in sulphuric acid. The ore is reacted with chlorine to form the liquid titanium tetrachloride, and this after having been purified by distillation is "burnt" in oxygen under very carefully controlled conditions to produce titanium dioxide.

Whichever process is employed, various additives and treatments confer on the product the particular properties desired by the different user industries.

Not only does this pigment have outstanding whiteness and pigmentary power, but it is also non-poisonous, a virtue which is of great commercial value. It is used extensively for paints, inks, papers, plastics, textiles, floor coverings and many other products.

With a capacity of around 170,000 tons a year from its two plants in Great Britain and three overseas, BTP is now the largest manufacturer of titanium dioxide pigments outside the United States, and third in world order. It is a considerable exporter, some 38% of the English output being sent abroad to around 70 countries, representing some £6 million worth of exports last year. Altogether British Titan Products employs nearly 3,000 people in England and an additional 1,100 overseas. The overseas plants betweeen them manufacture about 60,000 tons a year, supplying markets within economic range.

The English factories

The company's first factory was at Billingham, adjoining the ICI plant, and it now covers something like 18 acres. Opened in 1934, its output in the first year amounted to 950 tons of pigment. Nowadays it is of the order of 27,000 tons annually.

BTP's other English plant is at Grimsby on the bank of the River Humber, and covers a hundred acres. It was officially opened by the Duke of Edinburgh in 1949 and has a capacity of 80,000 tons a year. It is the biggest single titanium dioxide plant in the world—and incidentally, fronted as it is by lawns and flower beds, a standing proof that a chemical plant need not be ugly or unattractive. It is worth while noting that BTP undertook the construction of both these plants itself. The company uses its own processes for the manufacture of 'Tioxide' (the trade mark

BTP's Chairman, Mr. G. H. Beeby

for its titanium dioxide products) by the two routes, sulphate and chloride, and designs its own plants.

The overseas factories

After the 1939–45 war there was a phenomenal demand for these pigments, and BTP decided to meet it in some measure by local manufacture overseas. Australia was the company's first choice, and a site was found in Tasmania, production starting in 1949. The sales and technical service centres are, however, on the mainland at Melbourne, Victoria. Capacity is currently of the order of 22,000 tons annually, and ICIANZ is the sales agent for Australian Titan Products.

The second overseas factory was built at Durban, on the east coast of South Africa. This was opened in 1961, and so large has proved the demand for its products that already expansion is called for. Here again ICI is the sales agent for South African Titan Products.

The third overseas plant is in Canada, on the St. Lawrence river near Sorel in the province of Quebec. It started production in 1962, and the capacity of this plant is also having to be extended, to some 24,000 tons.

Coming nearer home, a fourth overseas plant, but this time in Europe, just across the Straits of Dover at Calais in fact, is due to open in 1967, with provision for an annual capacity of 25,000 tons of pigment. This plant represents one of the biggest British investments in France since the war. It is intended to supply the whole of the European Common Market.

Mining the two basic raw materials

But BTP is not concerned solely with processing. Being, in the modern idiom, "vertically integrated," it possesses considerable technological and financial interests in the mining of the two basic raw materials from which 'Tioxide' is produced. Ilmenite is mined in Western Australia, and by the end of this year rutile will be shipped from Sierra Leone, where BTP, with an American partner, is developing the world's biggest known deposit of this mineral.

40 Australian Titan Products factory at Burnie, Tasmania

The Research and Technical Service Laboratories

On the ever-important research side BTP now spends over £1 million a year. Very great emphasis is placed on research, for two reasons. First, as BTP is a company concentrating almost totally on a single product, titanium dioxide, it is essential to its prosperity that it should remain technically in the lead. Although the basic chemical remains the same there is the widest scope for variation in detail, as for example size of particle, chemical treatment, coating and so on, which in turn affect such qualities of the pigment as whiteness, opacity and ease of dispersion. Secondly, the fitness of a pigment for use can be affected by changes in the processes used by a customer or by technical developments in his methods of manufacture. Technical service to the customer has from the start been an essential part of BTP's functions, and this involves close collaboration with the technical staff of manufacturers.

BTP has built a group of laboratories at Stockton-on-Tees at a cost of £1m., which are second to none in equipment and facilities, and from August 1963 the whole of its research and technical service work has been carried out there.

In addition to the laboratories the company maintains one of the largest and most modern weathering stations in the world at Carlton in Durham. There, samples of paints, plastics, man-made fibres and other materials containing 'Tioxide' are exposed to the atmosphere under carefully recorded conditions, while arrangements are maintained with similar testing centres in different climates, such as ICI's own testing and weathering station at Brixham in Devon, at Brisbane and Melbourne in Australia, Durban and Johannesburg in South Africa, Sorel and Toronto in Canada, and in Florida, where the combination of bright sunlight and humidity soon uncovers any defects in paint!

Paints take most of the pigment

BTP's products find their way into a great number of manufactures. Pride of place goes to the decorative trades and paints. Today titanium dioxide pigments are used in the majority of coloured paints and almost the totality of white ones. To their presence the consumer public is in debt for all the bright, clean pastel tints which are now so popular but which only a generation ago were impossible to produce. They have also contributed largely to the development of easy-to-apply paints and thereby to the vogue for do-it-yourself decoration. Because they are non-toxic, paints based on these pigments are particularly useful for hospitals and all objects in contact with foodstuffs, kitchen furniture, children's toys and the like.

Industrial finishes of all kinds provide a large market for 'Tioxide,' particularly in the motor trade and for domestic machines, bathroom fittings, and the painting of ship superstructures.

Use in plastics and rubber

'Tioxide' is an ideal pigment for almost all types of plastics. It is likely to be found in the highly coloured barrel of one's ball-point

South African Titan Products factory at Umbogintwini, Natal

Typical BTP advertisements in technical publications

pen, in leathercloth or any plastics-coated fabric, in the moulded fluorescent light fitting above uncountable office desks and—because of its non-toxicity—in plastics containers for food and drink.

White-wall motor tyres and the white rubber rollers in domestic wringers, as well as the white and coloured soles and welts of sports shoes, are typical of its applications in the rubber trades, while it has been used in linoleum since the pigment first became commercially available. More recently it has been used for brightening concrete and even asphalt floors.

In paper, inks, fibres and enamels

Enough has probably been said to demonstrate the variety and the usefulness of the 'Tioxide' pigments, but without going into detail it may be worth mentioning that in the manufacture of paper and board, of printing inks—particularly the glossy coloured inks used in high-quality letterpress work—for man-made fibres and in textile printing, and in the whole range of vitreous enamels used in such things as stoves, cooking utensils, table tops, baths and tank linings, these pigments make a distinguished contribution.

Many other uses

There remain to be considered the equally important parts played by 'Tioxide' pigments in the treatment of leather, in the production of a great variety of cosmetics (where once more non-toxicity is a paramount virtue, and where very small quantities are often sufficient to give the desired result), in the making of soaps, and in many other versatile applications from heat-resistant glasses to electric lamps, from the coatings of pills to fluorescent tubes, and from wax crayons to welding electrodes.

Titanium dioxide itself is produced in two fundamental types (anatase and rutile), which differ in crystal structure. These in turn are produced in a variety of grades, each carefully designed for a particular set of requirements. Rutile grades (having the crystal form of the titanium dioxide in the mineral of that name) are generally favoured for most industrial uses because of their durability and economy. Anatase grades are preferred at present for use with textile fibres and some applications in the paper industry. Both anatase and rutile grades are made from ilmenite by the sulphate process, and the company is now also making rutile pigments by its new chloride process, which, as already noted, uses mineral rutile as raw material. BTP manufactures upwards of twenty different grades, and feels that the description of 'Tioxide' as a universal pigment is not exaggerated, for wherever whiteness or brightness of colour is required 'Tioxide' is indicated. Over 1,300,000 tons have been consumed since the first factory began operations in 1934.

Other titanium compounds from TIL

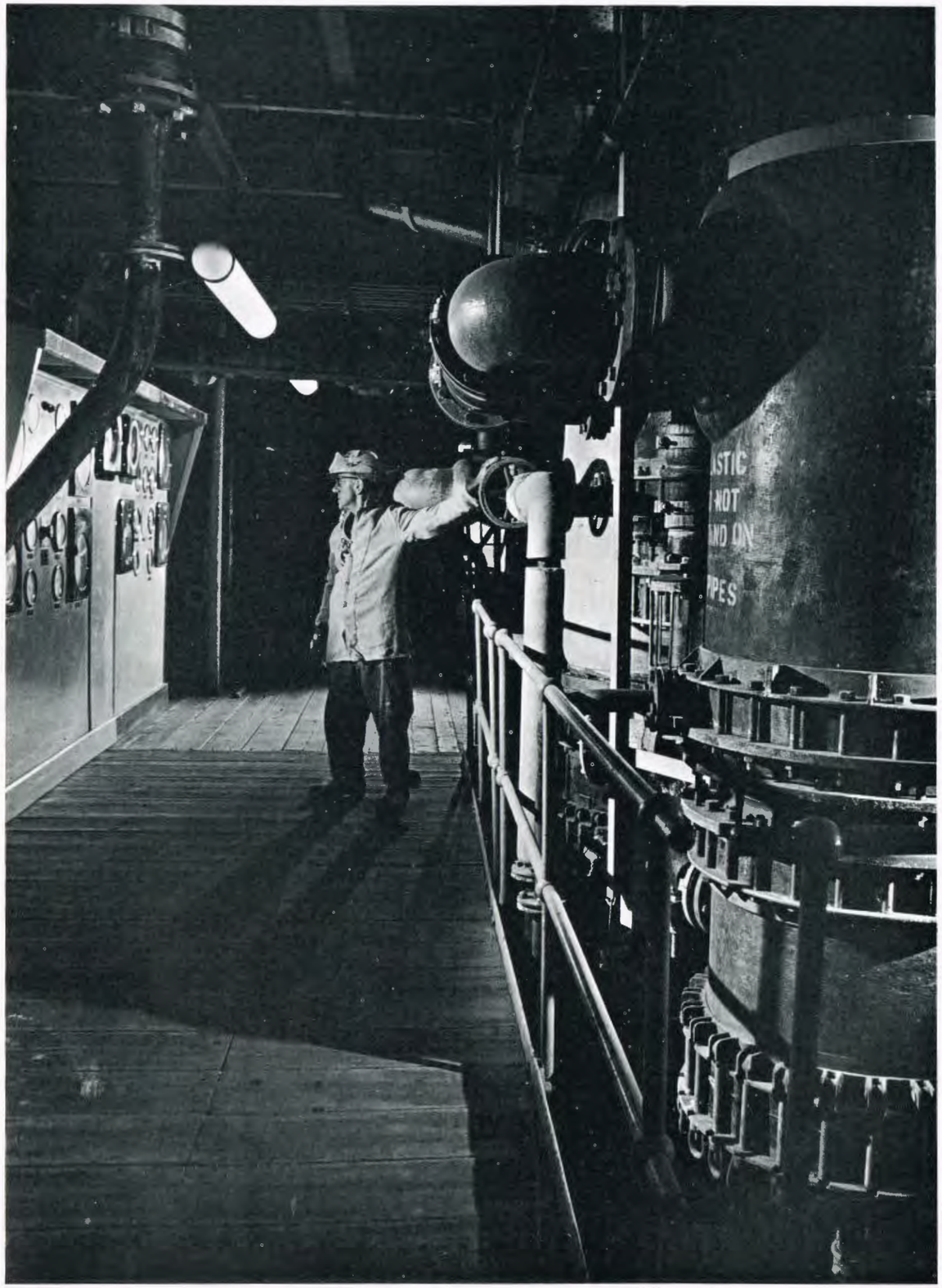
BTP itself has a subsidiary, Titanium Intermediates Ltd., or TIL, which was formed in 1954 to manufacture titanium tetrachloride. This chemical is the starting-point for the production of titanium metal—much in demand for its unique combination of lightness, strength, and resistance to corrosion and heat—and for a number of chemical compounds that have an increasing range of industrial uses. Milk bottles are now coated with an extremely thin layer of a titanium compound which greatly reduces scratching and breakage.

BTP sets much store by its new chloride-process pigment made from titanium tetrachloride produced by TIL. Its outstanding whiteness makes it something that no other European manufacturer can match. BTP thinks it probable that this pigment will be the choice for all decorative and industrial paints, inks and plastics of the very top quality and that it will enable the company to boost its exports still further.

Mr. George Beeby the Chairman

BTP's Head Office is in London at 10 Stratton Street, W.1. It has sales offices in Birmingham, Manchester and Glasgow, and a whole lot of overseas associates and mining subsidiaries. The chairman is Mr. George Beeby, who is well known in ICI as a former Chairman (1953–57) of ICI's Salt Division, now a part of Mond Division. Mr. Beeby is also Chairman of the Economic Development Committee for the Chemical Industry, a Council member both of the Chemical Industries Association and the Society of Chemical Industry, and Chairman as well of the Chemical Divisional Council, British Standards Institution.

ICI is represented on the board of directors of BTP by Mr. John Townsend, a Director of ICI, and Mr. A. E. Frost, the Treasurer.



BTP production of 'Tioxide' pigment at Grimsby: bottom of a concentrator

ICI in DENMARK

by Ian Brook

Changing of the Guard at Amalienborg Palace, Copenhagen

Danish butter, Danish bacon, Danish design . . . the non-Scandinavian visitor to Denmark has a few starting points from which to begin an acquaintanceship with the country. Perhaps, too, at the back of his mind there is Hans Andersen: "Eyes as big as the Round Tower of Copenhagen," he distantly remembers. He wants to know more about Denmark. Let him then by all means start at Copenhagen. Let him sail in from the open sea past the Little Mermaid, or land at Kastrup Airport which lies on the island of Amager (an island as flat as a billiard table) just south of the capital. What does he find?

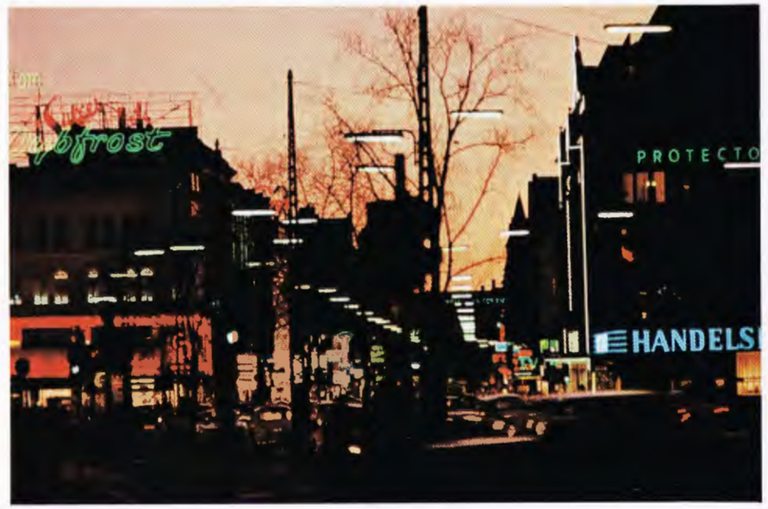
The first thing that strikes the visitor is that for a country of 4·7 million people Copenhagen is a surprisingly large city. In fact one-third of the Danish population live in and around Copenhagen. Obviously, too, a city of that size is going to exert a very considerable influence on a country, the total area of which is just over half that of Scotland. Copenhagen is indisputably the centre of Denmark and the Danish way of life, yet paradoxically lies on the country's eastern edge. An understanding of this paradox is of the utmost importance even to a casual visitor to Denmark if he is to grasp the factors which have made this country what it is and are still influencing the way in which it is developing.

Look for a moment at the geographical position of Denmark. It is wedged between the North German land mass and the Great Scandinavian Peninsula (Sweden and Norway). The long Jutland peninsula has a frontier of 42 miles with Germany. Otherwise Denmark consists of some 500 islands: the largest of these, Sjaelland—on which Copenhagen stands—is separated at its northern point from Sweden by a channel only three miles wide. This special situation has naturally played a big part in Denmark's history. The country emerged from the Middle Ages as a great and powerful kingdom. The Danes ruled over Norway, the southern part of Sweden, large areas of what is now northern Germany and the Baltic coast, Greenland, Iceland and the Faroes. Copenhagen was a natural focal point for this large dominion: the Dano-Norwegian fleet, based on the capital, dominated the north. Through the centuries, however, the Danish possessions were whittled away. Sweden emerged as a great power in the seventeenth century, the southern part of the country was re-united under the rule of the Swedish King of Stockholm, and the Swedes came also to dominate the Baltic. Norway was lost by the Danes during the Napoleonic Wars, and Schleswig-Holstein was lost following the short but disastrous war with Bismarck's Prussia in 1864. Copenhagen remained the capital of Denmark, the seat of the Danish monarchy, the largest city in Scandinavia. By tradition it is cosmopolitan, and thanks to its position it is still a flourishing commercial and maritime centre. From Copenhagen, Greenland and the Faroes are still administered; but Iceland became independent in 1920 and a republic in its own right in 1944.

Although consisting of so many islands, modern Denmark is compact. The countryside is by no means as flat as is sometimes believed. While admittedly the highest point in Denmark is 530 ft., the impression overall is of undulating, fertile countryside spread out under a wide sky. Beechwoods and white farmhouses blend into the landscape; the sea is never far away. Indeed, in Denmark a vista of low-lying islands and stretches of water constantly recurs. A glance at such a landscape confirms the importance of agriculture to Denmark. But industrialisation is fast progressing. Industrial production overtook agricultural production (in terms of value) in 1955, and last year for the first time industrial products accounted for over 50% of total exports.

As industrialisation goes forward, the towns are playing a greater and greater role: the drift from the countryside is a significant factor in modern Danish life. Owing to its very size Copenhagen acts as the biggest magnet of all; but every effort is being made to encourage investment in other areas of the country. Since all raw materials have to be imported and access by water is relatively easy all over Denmark, diffusion in this way should not cause too great a problem. Meanwhile the rivalry between Copenhagen and the rest of the country continues—even intensifies. The Danes characterise Copenhageners as being lively, cultivated and excitable. At the other end of the scale, the Jutlanders are typified as shrewd, quiet and slower-moving. Between these poles the Danes move, and a certain polarity in the national character is a source of strength to a society which must keep up with the times.

Nature has granted the Danes comparatively little apart from some fertile land and a temperate climate (similar to that of northern England). Historically speaking, agriculture has been a natural base for the Danish economy. Agriculture, however, has been coupled with a determination to progress and to improve the general standard of living. Co-operative efforts have led to improved agricultural production and efficient export marketing. Similarly the maritime tradi-



The neon signs light up as night falls in Copenhagen

tion of Denmark has led to world-wide shipping interests, and trade and commerce have followed the red and white Danish flag. Finally, industrial production often founded on small, even family units, has progressed rapidly in recent years. It is significant that in this sector the manufacture of machinery is now more important to the country's economy than for example food processing. It is an impressive fact that the Danish gross national product has grown an average of a real 5% (corrected in terms of constant prices) every year since 1957. This rate of growth naturally reflects itself in terms of standard of living. Already by 1962 the average income per head in Denmark was £450 (cf. £424 in the UK). The Welfare State has long been established in Denmark. Incomes are rather evenly spread. Denmark is an important and expanding consumer market, in spite of its small population. History has forced change upon the Danes: they have been compelled to compete and progress. Their geographical situation obliges them to be international in outlook and trade. Their main trading partners are Britain and Germany, though in addition the EFTA agreement has given a tremendous stimulus to inter-Scandinavian trading. It is natural that the Danes have watched with concern the split of Europe into two trading groups. A low tariff policy has meant that Denmark has been able to some extent to have the best of both worlds: thus 21·4% of all Danish imports come from West Germany, while Denmark is only able to send 17·3% of her exports in return. 22·6% of all Danish exports go to Britain, while only 13% of all imports come from Britain. In the long term this imbalance is unsatisfactory to Denmark, and the main effort of Danish foreign policy at present is directed to bridging the gap between EFTA and ECM or, failing that, to finding new export markets which can take the place of ECM.

The Danish way of life is enriched in many ways by pursuits and occupations that have developed over the years from traditional activities. Denmark has a

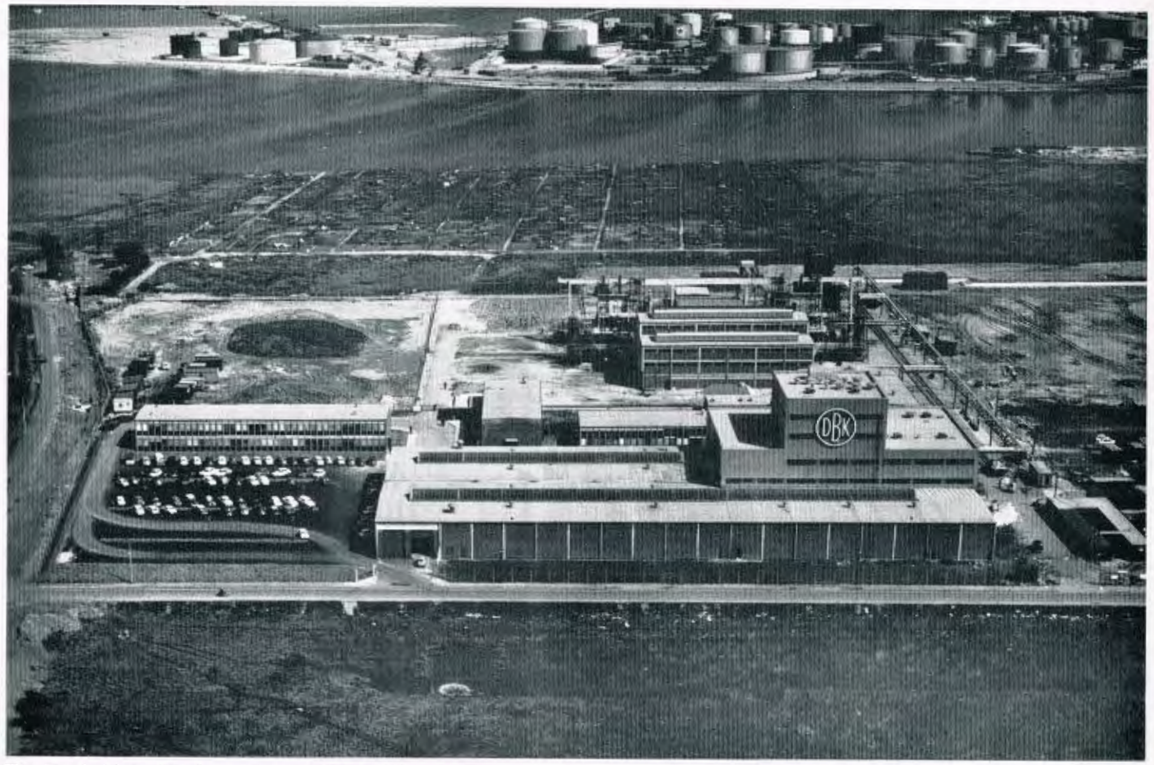
Inside Hans Andersen's house

coastline of 4,644 miles: this has meant in sport, for example, that the Danes are pre-eminent in events which take place on the water, such as sailing, rowing and canoeing. A high proportion of Danish households own a second house or summerhouse, and this is set preferably near the coast, so the family can enjoy the beach at weekends or during holidays. Simple white or brick churches are to be seen all over Denmark, but religion does not exert a great influence on modern Danish society. Church attendance is estimated at 5% of the population. The Church is a department of State, and the official religion is a form of Lutheranism.

Most Danes enjoy the appeal of the visual arts, and it is in the field of architecture and design that modern Danish artists have made their greatest contribution. On the one hand a tradition of practical building, and on the other a tradition of craftmanship have stood these artists in good stead. Names such as Jacobsen and Utzon have become famous in terms of international architecture, and in articles such as furniture, silverware and kitchenware the Danish insistence on a clean flowing line coupled with a practical simplicity has had a considerable influence on all design since the war. This love of what is pleasing to the eye has caused the Danes over the last century to lend great support to their ballet. The Danish Royal Ballet is one of the leading companies of the world: from the complaints of Copenhageners when the company goes on one of its foreign tours you realise how much it is appreciated.

How does ICI fit into the Danish way of life? Our business in Denmark goes back to the days before World War II, and we owe much to the efforts of two former agents, Mr. A. Andreasen, whose company Holger Andreasen looked after our chemicals business until last year, and Mr. H. Nielsen, OBE, who was appointed dyestuffs agent as far back as 1932. Both of them continue to assist our efforts as directors of our present selling organisation. As you would expect, however, ICI's strength lies more in co-operating with Danish industry in the production of consumer-orientated goods than in the supply of bulk chemicals. The Danish plastics industry is the most sophisticated in Scandinavia. It is no coincidence that the only manufacturing undertaken by ICI in Denmark is that of 'Alkathene'—ICI's polythene. For this purpose ICI Plastics Division founded jointly with the large Danish shipping and manufacturing concern A. P. Møller the company Danbritkem. Danbritkem started producing polythene in 1962, its original capacity being 12,000 tons p.a. Since then capacity has been increased to 25,000 tons. Danbritkem soon succeeded in getting a large share of the Danish home market but has always fostered an interest in exports. All other plastics are imported, and it seems likely that as the use of plastics in the building industry is developed Plastics Division should find a particularly go-ahead market in Denmark. Meanwhile sales of plastics over a broad front and of plasticiser alcohols contribute substantially to our turnover in Denmark. Another significant area for sales of ICI products in Denmark is that of textiles. 'Terylene' has now been a household word for ten years. Although BNS (and more recently ICI) have sold nylon in Denmark for many years, only in autumn 1966 will the Bri-Nylon trade mark and quality control scheme be advertised to the Danish public. It is typical of the international nature of the Danish market that in the case of 'Terylene' only about half of what is consumed was originally sold to the Danish textile industry by ICI (Danmark): the other half comes in from the UK, Switzerland, Sweden and Portugal in the form of semi-manufactured yarn and cloth. Similarly a large proportion of the 'Terylene' ICI (Danmark) do sell to the Danish textile trade is exported to Sweden and Norway in some intermediate form. Our connection with the textile industry is founded on the dyestuffs business, and cross-fertilisation between dyes and fibres is a source of strength to ICI in Denmark. Nor, while speaking of auxiliaries for the textile industry and for other industries too, should we forget the substantial sales of trichloroethylene and perchloroethylene.

Denmark has a considerable production of refrigerators (mainly for export). ICI supplies polyurethanes for insulation and 'Arcton' for refrigeration. Weedkillers and insecticides for use in connection with agriculture are natural sellers in Denmark. Finally, perhaps, we should name as a major single product sold by ICI in Denmark, soda ash, for use in the production of all types of glass—from the bottles for Tuborg beer to the finest examples of Danish design.



The Danbritkem Works on the outskirts of Copenhagen

ICI's future policy in Denmark must obviously be adapted to the way in which the country develops. How far will industrialisation go in Denmark? Is it eventually going to be inhibited by the tendency to concentrate on small units? At all events it looks as though, in order to compete in world terms, the Danes are going to concentrate on a few specialist types of manufacture (e.g. packaging, prefabricated building), and ICI would be wise to work closely with leading firms in these sectors of industry.

Similarly, how is Denmark going to cope with the future development of Europe? Is she going to be obliged to buy more from Britain since her exports to Britain are doing so well? At present Denmark is flirting with Russia and East European countries in search of new markets: how far will Communist countries insist on supplying a fair share of commodities (e.g. chemicals) to the Danish market in return for imports of Danish machinery and ships? All these changing factors are symptomatic of modern Denmark: it is essential for any supplier to be constantly reassessing his position in such a market.

Silver "Copenhagen" teapot, cream jug and sugar bowl designed by Henning Koppel for Georg Jensen Silversmiths Ltd.

INFORMATION RETRIEVAL

Old craft—new tricks

By W. E. Batten

"INFORMATION retrieval? Good heavens, what's that?" you react. Fair enough. But there was a time when you might have turned the same fishy eye on method study or operational research or many other seeming upstarts. Expertises tend to multiply by the fencing off of an activity previously regarded as applied common sense. It is to combat this suggestion of separation that this article has been written.

I will not defend the term "information retrieval." It implies an achievement—a result—whereas the things I want to talk about are better described as information organisation and information extraction. There used to be an adequate word for these activities and I won't shy at using it—librarianship. But there are notable differences between librarianship (as it has been understood) and information technology (as it will come to be understood). Whether the subjects will or will not grow professionally distinct seems relatively unimportant.

Why then is yet another expertise coming into being? The reasons, as usual, are many and interacting; the following are the major ones:

1. The volume of information is growing, ever more rapidly.
2. Its nature and content are growing more complex, i.e. it is ceasing to be pedigree (e.g. chemistry or physics) and is becoming more and more cross-bred (e.g. biophysics, automation engineering, space physiology).
3. The nature of an individual's work is itself becoming more complex in the same sense as (2) above (i.e. his work takes him outside his particular subject). A chemist serving a technological project needs technological information, not just chemical information.
4. The advance of computer technology (coupled with the need to conserve qualified manpower for appropriate tasks) invited new techniques for dealing with information.

With some over-simplification we may say that the old ways ended in 1939 and that the new ways began in 1945. Let us look briefly at the old ways as an introduction to the new. Much generalisation is inevitable in so brief an article; if I outrage my professional colleagues, I solicit their discreet indulgence.

So long as the traditional disciplines of science remained essentially self-contained and so long as an individual's intellectual problems were concerned with one or other of these disciplines, it was adequate to regard a book (or a paper, or a report) as being about some quite self-contained topic. One or a few words were sufficient as document "handles." This basis persisted, very successfully, for centuries. It gave rise to the traditional card index found in most libraries where, in addition to an author index, there was also a subject index where an item could probably be found in response to one of a few key words proclaiming its essential content. Such subject indexes were hand-made (by dedicated and ill-appreciated effort) and, in the hands of their makers (assisted by good memories), contributed notably to man's laborious ascent. It must be noted, in passing, that there were many meritorious attempts to universalise the key words used in such indexes. The new causal factors today are mentioned in (1), (2) and (3) above—indeed, (2) and (3) are virtually the same thing, in that (3) gives rise to (2). If an author is describing a piece of multi-scientific endeavour it follows that his paper cannot be represented (in the card index sense) by a mere three or four words (unless those words are of such generality as to be no better than those strangely forbidding signposts which invite us to "The North"). But further. As papers become ever more cross-disciplinary we ought to provide not only for the retrieval of the main theme, but also of the practice and the reasoning supporting it. Such work can have later value in new situations.

Thus, to put the matter broadly, retrieval must be made possible from many viewpoints, and this means awarding many "call-signs" to a document. These call-signs have come to be known by many names, e.g. key words, descriptors, Uniterms, aspects and features. We will settle for descriptors. It will follow that any but a very simple document deserves many descriptors. Ten is common, twenty-five frequent and one hundred would not be unreasonable among patent specifications. Descriptors need not be wholly drawn from subject content. Authors' names, place names, dates, project numbers, categories—even the colour of the cover—can be displayed if desired.

So we have to deal with (a) a rapidly growing collection of documents and (b) a much increased number of descriptors per document. I will call the "collision" of a document with a descriptor a "conjunction." Thus, if we have one hundred documents each indexed by ten descriptors we have one thousand conjunctions to organise. Clearly the number of conjunctions involved today is immeasurably greater than was its pre-war equivalent: so much greater that wholly manual methods are scarcely feasible, and barely economic. But before considering so-called machine methods, let us briefly see how the descriptor system works in principle. Each item (paper, report, pamphlet—whatever is being organised) entering the collection is given a unique identifying number (the accession number—nothing new here) and is then awarded descriptors by a suitable qualified person who understands the document. A document might receive the descriptors "Ships," "Collision," "Fog," "Radar," "Failure." These descriptors serve each, individually, as "handles" for retrieval. They are not to be regarded as an indivisible group. When an enquirer poses a question, the same procedure is applied. His question is represented by a selection of descriptors. It is then a matter

Centek planning session. Left to right: P. M. Adams, R. A. E. Ellis, Dr. W. E. Batten, Mrs. S. E. Stidworthy, A. D. Shillingford

of providing a way of matching the descriptors of a question with the descriptors of documents. Note that the document just described would respond to Ships/Collision, Collision/Fog, Radar/Failure, or to any other combination within the five terms—or even to each term taken by itself. The crucial point is that there may be many other documents in the collection that would also respond to (say) Radar/Failure, although their remaining descriptors might relate to aircraft and have nothing to do with collisions or ships. Later we will return to the purely physical problems of matching questions with documents.

There are two imperfections in the descriptor technique as so far presented, viz.:

1. Some people might prefer "boats" or "vessels," etc., instead of "ships"; "mist" instead of "fog"; "breakdown" instead of "failure."

   This difficulty is minimised by using a specified language for indexing and search. A compilation of such a language is usually called a controlled vocabulary or (in its more developed form) a thesaurus.* How to prepare such a language is a story in itself. Suffice to say that a thesaurus is desirably personal to the organisation that uses it. Wide universality is an unlikely property of a thesaurus, at any rate in technological areas.
2. The document mentioned above would respond to Ships/Failure. In one sense a ship that collides does fail, but the enquirer would probably be looking for more direct kinds of failure, and would regard the reference as irrelevant. This phenomenon is called a false drop, and quite elaborate indexing procedures have been proposed to deal with it. They are outside the scope of this article (a) because of their complexity and (b) because they are as yet imperfect. For the present, false drops must be dealt with by benevolent common sense.

** A thesaurus, in our sense, is not quite the same thing as Roget's classic. To us, a thesaurus is an alphabetic word list in which we are directed (say) from "farming" to "agriculture," i.e. from numerous daily terms to a single indexing term.*

Finally, we must consider the operation of matching. There are wholly traditional methods of displaying the results of co-ordinate indexing (as the descriptor technique is called), methods that require no machinery beyond typewriters (indeed, pencil and paper will suffice). There are intermediate methods that employ punched cards, but not usually card-sorting machinery. And there are methods involving the use of computers. Size and complexity of the collection largely determine the methods to be used. In general, the larger the number of conjunctions to be handled, the stronger the case for machine assistance.

A technique that is gaining favour in cautious yet progressive circles is one in which the computer is employed to organise and to up-date the collection, but is rarely used for actual searching (matching). Such a technique is being adopted for the index of ICI technical reports—"Centek." It makes regular periodic use of a computer for inputting new material—an operation that can be done in off-peak computer hours—

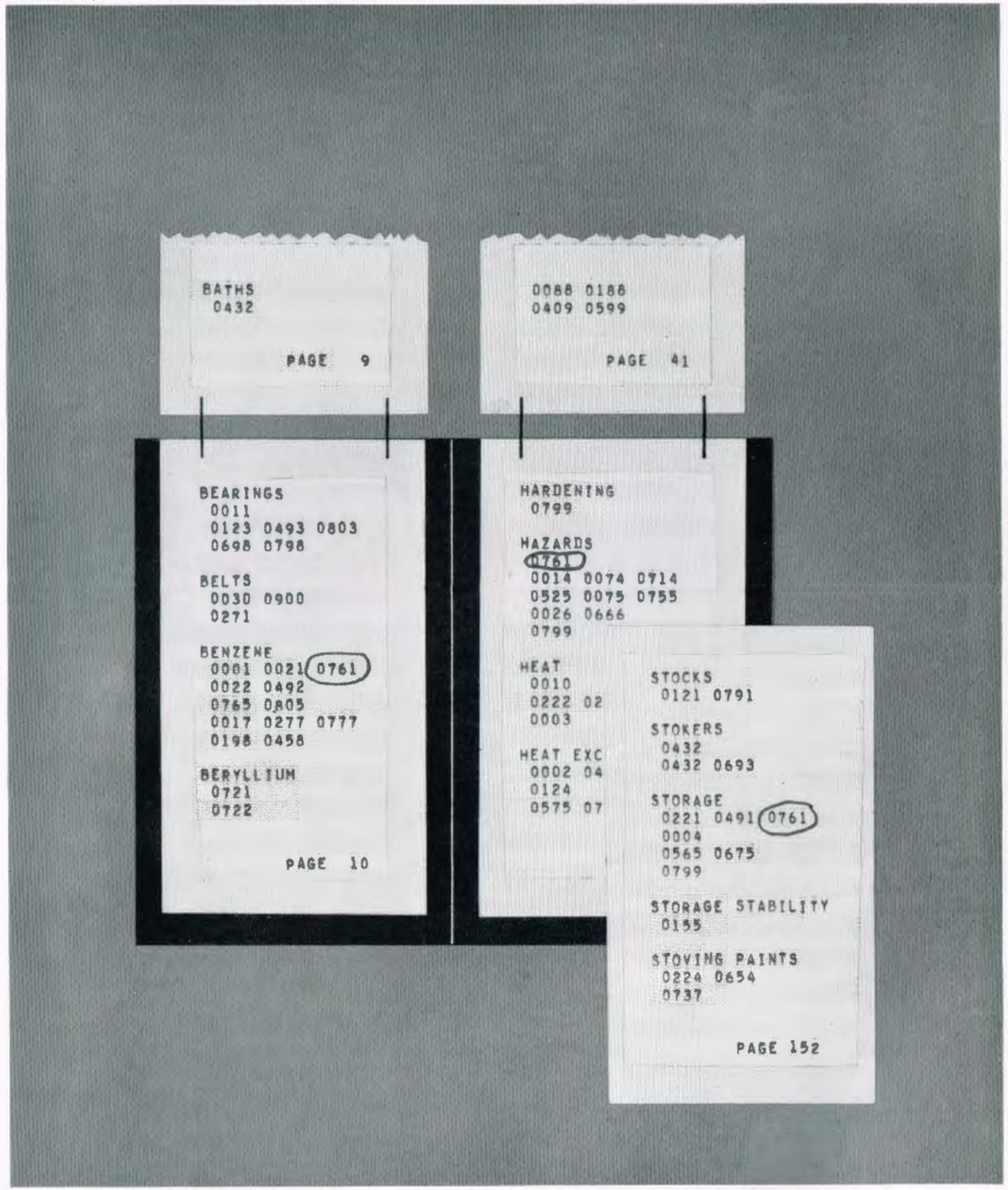


Fig. 1a
Simplified representation of a computer-produced print-out index. Two such indexes bound side by side are known as a "dual dictionary." To search for documents on "Hazards in the storage of benzene" one first compares the lists of document accession numbers under "Benzene" and "Hazards." Number 0761 is common to both. Turning to the entry for "Storage" on page 152 in either half of the dual dictionary, one finds number 0761 listed there. Document number 0761 is therefore concerned with "Hazards in the storage of benzene"

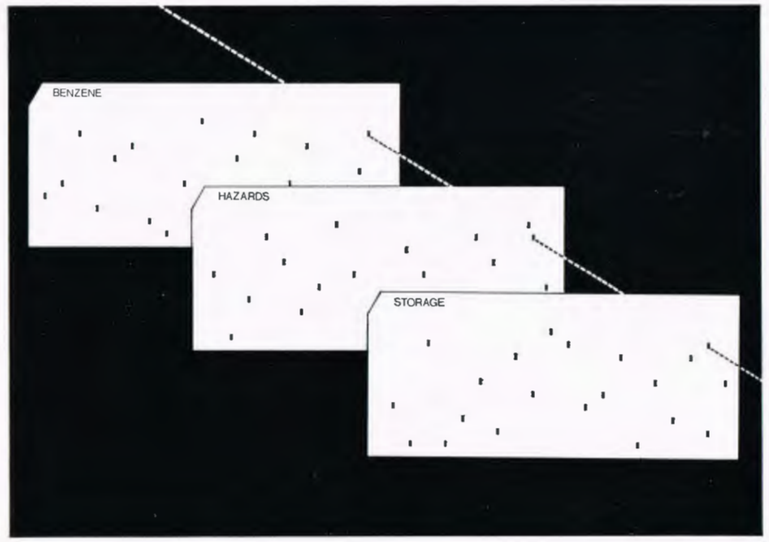


Fig. 1b
A set of perforated cards for identifying documents on "Hazards in the storage of benzene." The coincident holes (linked by the dotted line) represent document number 0761, since each is punched at column 76, row 1, on a standard card

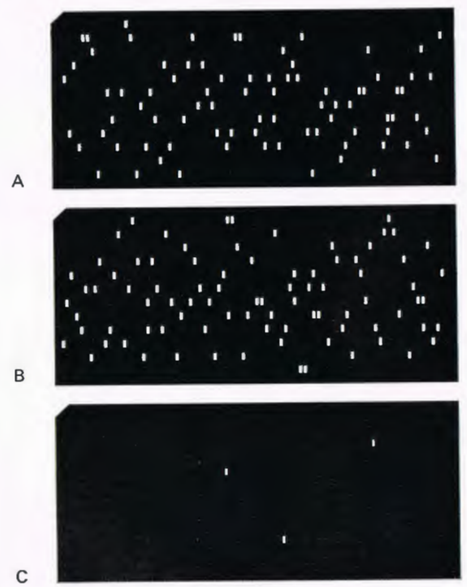


Fig. 2
Optical coincidence search tools are capable of great selectivity. A and B are reproductions of actual punched cards. When superimposed (C) they are shown to have only three punchings in common

but the main product of this operation consists of search tools designed for manual use. The occasional complicated search can nevertheless be done on the computer and occupies only very little machine time, particularly if questions can be batched.

The result of the input operation is that all the conjunctions are collected and stored in a form that is meaningful to the machine—usually on magnetic tape. From this store there can be constructed, by fairly simple machine operations, a variety of self-explanatory manual search tools. Centek will produce two such tools, (a) a print-out in which, for example, all the accession numbers that carry (say) "benzene" as an indexing term will be printed under "benzene" and all those carrying (say) "storage" will be printed under "storage." Co-ordination to find accession numbers common to two or more descriptors is performed readily by eye (Fig. 1a); (b) a semi-mechanical display in which co-ordination is performed by putting one perforated card on top of another (any number of cards may be so superimposed) and noting the positions of coincident holes (Fig. 1b). These two search tools can be up-dated frequently, and are readily replicated for use in many places. In the Centek service they will be distributed to all Division Information Units for the use of Divisions.

Searches based on descriptors will throw up some references that are not very useful to the enquirer. To assist in their rejection, Centek will distribute (so far as security permits) a concise collection of titles and abstracts, so that the full report need not always be read.

One word of clarification. In the system described, the computer is being used almost solely as a clerical tool. The intellectual contribution is still made by the indexers and abstractors in the various Information Units of the company. If their analysis is deficient, the computer can do nothing to make good the deficiency. Research is in progress in many parts of the world to discover a way of using the computer for the intellectual analysis of literary text, e.g. by indexing the most frequently occurring words in a text. Results are not without promise, but cost and performance are not yet attractively related.

Information Retrieval will sound prosaic, even plain dull, to many of you. But for those engaged deeply in its enormous problems and modest successes it has a compelling fascination. Alas, we cannot enter fully into the joys and sorrows of each other's activities; our mutual understanding might be better if we could. But if any reader's curiosity is aroused by this necessarily condensed account, he will assuredly find willing tutors (all with individual reservations as to both theory and method!) among the author's good friends and colleagues in the various Information Units of the company. Make them your good friends and colleagues too!

People & Events

Oxfam fertilizer order. *Part of an order from Oxfam for 2,000 tons of sulphate of ammonia from the Agricultural Division's factory at Billingham is loaded at Middlesbrough Docks for shipment to India. Together with an earlier shipment of 1,000 tons, and 1,100 tons of superphosphate from Scottish Agricultural Industries Ltd., an ICI subsidiary company, the fertilizer is to be used in the growing of high-yielding hybrid maize as part of an experiment supported by Oxfam to lessen the risk of famine in India*

First Aid finals. *A jubilant team from Olefine Works, Wilton, receive the ICI First Aid Trophy from Lord Beeching (second from the left), one of ICI's Deputy Chairmen. The finals of the competition took place at Imperial Chemical House on 15th March. Olefine Works have now won the Wilton eliminating round for three years running and the ICI Trophy two years running. Runners-up in the competition were the team from Dyestuffs Division's Huddersfield Works, and third place went to Nobel Division's Dumfries Factory team*

Light-headed. *A new safety helmet for policemen controlling traffic at night which incorporates a flashing lamp made by Lucas, using blue 'Diakon,' ICI's acrylic polymer. Current is provided by a motor-cycle battery, which can be carried in a waist harness*

Suchard choose 'Propafilm.' *All the film used to wrap the 1966 range of chocolate Easter eggs made by Suchard Chocolate Ltd. is 'Propafilm' O, ICI's oriented polypropylene film. Suchard chose 'Propafilm' because it gave better performance than the regenerated cellulose film the Company had used previously and because it cost less. The girls at Suchard who wrap the Easter eggs by hand find that 'Propafilm' is easier to fold because it is more pliable than regenerated cellulose film, and this allows them to do the job more neatly*

Press Conference. *Sir Paul Chambers, Chairman of ICI, with other members of the ICI Board, met City editors and other financial journalists at a Press conference in IC House on 8th March to explain and comment on the ICI Annual Report for 1965, and here Sir Paul is seen with (from left to right) Mr. A. E. Frost, ICI Treasurer; Mr. P. T. Menzies, ICI Finance Director; and Mr. F. C. Bagnall, ICI Commercial Director. The Report shows that during the year the ICI Group sold more at home and overseas than ever before. Group sales rose by £95·7m. to a total of £815·9m. for 1965, but trading profit fell from £113·1m. in 1964 to £112·9m. in 1965*

Severnside panorama. *A view of ICI's Severnside site looking north-west from the top of the 330 ft. high 'NITRAM' tower. In the foreground is the Compound Fertilizer plant, part of the Agricultural Division's Redwick Works. On the left of the picture is the Nitric Acid area and the 200 ft. gantry on the right is part of No. 1 Ammonia Plant—also Redwick Works. In the background is Heavy Organic Chemicals Division's Ableton Works*

New process trainer. *Mr. John Wilson, an Agricultural Division training officer, demonstrates the new Universal Process Trainer recently installed by the Division. The trainer, one of only three in Britain, has been developed by the American Carmody organisation from their old Link Trainer devices by which pilots could be trained in everything about controlling an aircraft without leaving the ground. The Process Trainer can be adapted to match any plant conditions, including an emergency, and can even be used to train people to operate a new plant before the plant is built*

Overseas Department posts. *Mr. Eliot Hodgkin, deputy overseas controller since 1956, has succeeded Mr. E. J. Langford as General Manager—Overseas on the latter's retirement. Mr. M. G. Davis, formerly an assistant treasurer, and Mr. G. J. F. Mackay, formerly Head of India Department, have been appointed Assistant General Managers—Overseas*

Plastic coal bunker. *Photographed above is the first all-plastic coal bunker for domestic use. Made of 'Alkathene,' ICI's polythene, it has a capacity of 18 cwt., comes in red or black, and costs £18. Available from Selfridges or Pontings in London or direct from Plastic Bunkers Ltd., 15 Queens Terrace, Southampton*

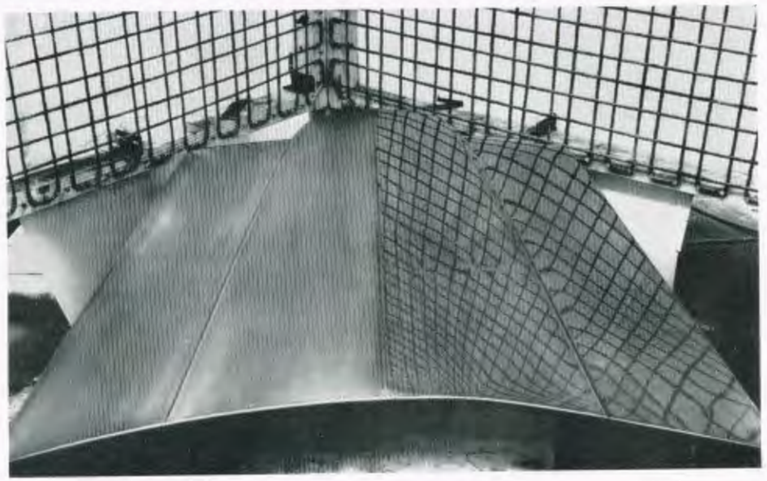
'Novolux' launched. *Ideal for such do-it-yourself jobs as garage roof lighting, house extensions, partitions and car ports is this new lightweight corrugated PVC sheet from ICI (Hyde). Called 'Novolux,' it is available in transparent natural, green and yellow in either 6 ft. × 2 ft. 6 in. or 8 ft. × 2 ft. 6 in. sizes, and the recommended retail price is 28s. and 37s. 4d. respectively*

Sindy wallpaper. *This new ICI wallpaper features Sindy, the best-selling doll in the UK, someone who is already a firm favourite. Shown on the wallpaper, as well as Sindy, are her boy friend Paul and her sister Patch. Sindy wallpaper is now in the shops and sells at a maximum retail price of 9s. 8d. plus purchase tax*

Nylon run stepped up. *Two 32-ton capacity vehicles, the first of a new fleet of 16 tractors and 32 trailers which will carry the growing output of nylon polymer chips to the spinning factories, at Pontypool, Gloucester and Doncaster arrived at Wilton Works on 21st February. The "nylon run" is a round-the-clock shuttle service. By using a staging point at Gloucester and a team of drivers, each lorry is kept on the move like a baton in a relay race*

Moon pictures. *Newsmen and scientists cluster around a picture receiver at Jodrell Bank Observatory on 4th February as the first-ever pictures from the moon's surface, transmitted by the Russian moon probe Luna 9, were received. Ilford photo materials were used exclusively by the Jodrell Bank Observatory team. (Photo courtesy "Daily Express")*

Railway book. *Messrs. Ian Allen have just published a volume, "Round the World on the Narrow Gauge," by R. B. Whitehouse and P. C. Allen (photographed above), one of ICI's Deputy Chairmen. This is a sequel to Messrs. Whitehouse and Allen's previous review of the narrow-gauge railways of Europe published in 1959. Their new volume is copiously illustrated with photographs, including many by Mr. P. C. Allen himself*



Spotting the flaws. *A process for detecting flaws in large metal surfaces such as car bodies, scooters, washing machines and cookers at the white metal stage of production instead of the semi-finished stage has been developed by Mond Division. It consists of coating the bare metal with a temporary highly reflective finish and examining it in an area enclosed by a grid of regular pattern. In our picture only the right-hand panel has been coated. Defects show up in certain irregularities in the reflected pattern*

RETIREMENTS

Dr. A. Caress

Sir Ronald Holroyd writes:

Alfred Caress, known affectionately as "Caro" to his many friends the world over, has enjoyed a career in ICI which must be the envy of most technical men. Since joining the Research Department at Billingham from Cambridge 38 years ago he has had the rare experience of being intimately concerned with the start and build-up through the crucial development stages of two of what are now ICI's most important spheres of activity, namely the plastics

and fibres fields. He was in at the birth of both Plastics and Fibres Divisions, being the former's first Development Director and, after an interim period as Chairman of 'Terylene' Council, the first Fibres Division Chairman. Dr. Caress was also one of the main people concerned with the formation in 1958 of Fiber Industries Inc., a joint company of ICI and the Celanese Corporation of America, which has already proved to be a great success. The widespread recognition of Caro's personal contributions in the plastics and fibres fields has recently been highlighted by his being given the 1966 Honor Award of the Commercial Chemical Development Association, this being the first time that the award has gone to anyone outside the United States.

The enterprises in plastics and fibres with which Dr. Caress has been connected have called for an imaginative view of possible future developments and trends, courage to take a calculated risk, cool judgment in the face of temporary setbacks as well as a great deal of energy and determination, and these are qualities he possesses to the full. It is easy to understand why, even as an undergraduate, he had a reputation for being able to supplement his income on the racecourse: he has certainly picked useful winners for ICI.

Dr. Caress was appointed a Director of the Company in 1960 and, on the retirement of Dr. Ferguson, was an obvious choice for Research Director. In this post he has done a great deal to stimulate detection of potentially worthwhile long-term targets for research.

Caro's warm and cheerful personality, his perhaps somewhat deceptive air of being easy-going and free from worry, and his ability to be the life and soul of any party, have made him a most popular figure both inside and outside the Company. We shall all miss him both as a friendly colleague and for the sound judgment he brought to our discussions of Company affairs. Our best wishes go to him and Mrs. Caress for a long and happy retirement.

Dr. J. S. Gourlay

Mr. L. H. Williams writes:

When Dr. Gourlay retired on 31st March he ended a career which had extended over 47 years—considerably longer than any of his colleagues on the ICI Board and remarkable not only for its length but also because the one-time laboratory apprentice succeeded in rising to one of the highest positions in the Company.

John Gourlay joined Nobel Explosives Ltd. as a laboratory apprentice at Ardeer in 1919, and it was during his earlier years with the Company that he took his first degree in science. He was transferred to Nobel Chemical Finishes, now the Paints Division, in 1929 and was appointed its Research Director in 1945. He was Joint Managing Director of Plastics Division from 1952 to 1957, and returned to Paints as its Chairman in 1957 and became a Director of ICI in 1959. He has been an Overseas Director, a Group Director and, since the reorganisation, in addition to

being Dyestuffs Division Liaison Director, has been responsible for the Company's building development programme.

He has always been a friendly and a stimulating colleague, but he not infrequently left one in doubt as to whether he really meant what he said or was just provoking his colleagues for the fun of seeing what their reactions would be. Many of his erstwhile juniors had good reason to be grateful to him for his ready understanding of their problems and the kindly manner in which he dealt with them.

Convinced as he always has been of the value of using scientific principles when trying to find solutions to non-scientific problems, it will be interesting to see how successful he is going to be with his Ayrshires and his sheep on his farm in Kirkcudbright, where he will no doubt spend a lot of his time in retirement.

We shall miss him both as a colleague and as a Director, but we shall hope to meet John and his wife Marjorie on many social occasions in the future.

OBITUARY

Mr. Ronald Farquharson

It is announced with deep regret that Mr. Ronald Farquharson, who at the time of his retirement at the end of 1963 was ICI Shipping Manager, died on 17th January after a long period of ill health. He was 65.

Mr. D. R. Hunter, Head of Central Distribution Department, writes:

One of the characters of the Company—this was the description so often attributed to Ronald Farquharson. An impressive figure of a man, his humanity and zest for life infected all those who met him both inside and outside the Company.

Joining Brunner, Mond & Co. in 1920, he later went out to ICI China. His experience there provided the foundation on which he later exercised his literary gifts, becoming a popular contributor to the ICI and other magazines.

Many will recall the delightful essays which made up *Confessions of a China Hand.*

Returning home in 1935, he eventually became Shipping Manager of the Company, based at Liverpool. The war years saw him having to handle a vital job with depleted staff, beset by fire-watching, and doing his bit as a special constable. His good humour and comradeship in those difficult days are remembered with gratitude by many.

At the time of his retirement Mr. W. D. Scott, then Commercial Director, commented on his valuable service to the Company in promoting exports and developing good relations with the shipping fraternity. Having inherited the benefits resulting from this work, I should like to express on behalf of myself and many others our appreciation of a truly warm-hearted friend.

To his widow, whose graciousness so many of us have appreciated, and to his twin sons, one of whom carries on the family tradition in the Company, we extend our deepest sympathy.

Britain's Water Supply

Continued from page 69

There is then a genuine conflict of opinion. On the one hand the Tees Valley and Cleveland Water Board, the Water Resources Board and ICI believe Cow Green reservoir to be the only practical way to supply Tees-side with additional water by 1970, and the Company (which can only speak for itself) believes that botanical damage, except to the 20 acres, would be negligible. On the other hand, the principal botanists and naturalists in Great Britain are concerned at the invasion of Upper Teesdale even though the direct consequences are only likely to be small.

The proposal is the subject of a private Parliamentary Bill, which is being promoted by the Tees Valley and Cleveland Water Board, and which will be heard early in the life of the next Parliament. Meanwhile the Company remains clearly at risk in the event of a drought and can only reiterate its wish to see an early practical solution to the problem of water shortage on Tees-side.

Dr. E. B. Abbot of ICI Fibres Ltd.

Dr. Abbot became Chairman of Fibres Division, as it then was, in April 1963. When the fusion between his Division and the former British Nylon Spinners took place and a new company embracing both —ICI Fibres Ltd.—was born on 1st January 1965, Dr. Abbot became its Chief Executive. His responsibilities and functions are virtually identical with those of a Division Chairman, although he looks to a Board in London rather than to a Control Group as do the Division Chairmen.

Dr. Abbot is yet another former Dyestuffs Division executive, of athletic frame and over average height, to become a Division Chairman, and now, like his friend and colleague Douglas Bell, to be the Chief Executive of a newly formed ICI company.

Rather less, perhaps, than some of his ex-Dyestuffs colleagues now in exalted positions in the Company, has he the Divisional manner, although his misprision of humbug or of pomposity is fully as keen as any of theirs. His manner, like his style of dress, is perhaps a token more formal than theirs, his courtesy, not more distant, but more—if one may distinguish in such matters—exact. He describes himself as a tidy man and this, one feels, is with him less a matter of habit than a reflection of character. He would have little use for undirected enthusiasm or for uncoordinated initiative, not because he does not set a high value on both enthusiasm and initiative in themselves, but because without a sense of direction they would seem to him merely untidy.

Dr. Abbot will not in all probability retain any particularly grateful memory of the year which has just passed. Indeed, it can require scarcely any imagination to realise that the opening months for a new organisation, which has been formed by what it would not be unfair to describe as the willing but gunpoint marriage of two highly independent and self-reliant concerns, each with an enviable public image and corporate pride of its own, was not going to be entirely easy. Any number of personal adjustments—quite apart from all the organisational, technical and commercial integrations—have to be made, and the man to whom all look to give shape to the new organisation, to inspire confidence in it, and to concern himself with all those problems of personal adjustment, is only human and cannot by the nature of things be wholly immune himself to doubts and anxieties. A quite unusual strain devolves upon his shoulders, and certain burdens which he cannot share with others. Dr. Abbot does not speak of these things, one senses them only in the eagerness with which he plans and looks forward to the days when the machine, as it were, will be run in and playing the rewarding part in amplifying Britain's economy which he firmly believes it will.

For Dr. Abbot is an enthusiast as well as an industrialist, and in speaking with him it is fully clear that he regards the orchestration of the manifold parts of a great industrial undertaking, so that it possesses a purposive shape and can be set to the fulfilment of considered objectives, as a creative achievement in which any man can take pride.

Indeed, his chief, if not his only complaint is that the diverse demands upon his time and attention, occasioned by the highly complex nature of ICI Fibres Ltd.'s activities, result in a certain degree of fragmentation of his life, and divert him from what he regards as the Chief Executive's *key* job—that of looking forward and shaping for the future. As it is he has to apportion his energies to satisfy the multiple exactions of his position, such as keeping in touch with customers and their problems and keeping an eye on trade relations in general, the work of the factories, the Company's overseas interests and the shaping of future plans and developments.

The range of the modern man-made fibre is enormous. From the ever-widening gamut of the textile trade—underwear, stockings, suitings, coats, and almost every article of apparel—through all the variations of what are known as domestic furnishings—carpets, chair covers, curtains, rugs—to the less popular but no less important requirements of the industrial market—tarpaulins, conveyor belts, laggings and linings—the demand is ever expanding and the specifications are always more sophisticated. The mere keeping track of such a business is a formidable task, and Dr. Abbot has to be something of an expert in every ramification of this terrain, in which the layman can, as it were, hardly see the trees for the wood.

But to him, doing this, and the planning of a sensible and realisable future for the new company, is what gives to an exacting life the savour of a continuing adventure.

Dr. Abbot is not a Scotsman, nor the youngest of a family of ten, for nothing. Born in Dundee and a graduate of St. Andrews, he has all a Scotsman's instinct for the realities of a situation, tinctured with that dash of romanticism which has made them outstanding in so many fields of human endeavour. Some years ago he took part in one of the advanced management courses run by the Harvard Business School. The course, which lasted some $3\frac{1}{2}$ months, postulated a highly sophisticated approach to management problems, and was conducted predominantly on a basis of real life case studies. Dr. Abbot feels that it

MIKE BUSSELLE

has benefited him greatly, especially when it comes to the vexed question of delegation. He learned, he says, to be more receptive to other people's ideas, to realise that other people may not do things in the way you would do them yourself and yet do them perfectly effectively, even perhaps better. But delegation, he insists, is not to be confused with abdication. And this will bring him back to one of the key tenets of his managerial creed, that people like to be given clear objectives and well-defined remits and then to be left to do the job as seems to them best. He believes in people operating to the limits of their remit, and even, if common sense dictates, a little beyond. But where they do, he expects them to understand what they are doing and to keep all those who may be affected by their licence properly posted on what they have done. This makes for mutual trust and group activity, in practice often the most fruitful of ideas as well as of results.

Dr. Abbot is glad that his membership of the Board of Fiber Industries Inc. takes him regularly to the USA. "You don't know much about textiles and textile fibres," he will say, "if you only know the United Kingdom." The "big, hustling, bustling market" of the USA is both a corrective and a spur, the Continent of Europe hardly less so.

Totally committed, as he so patently is, to his profession, Dr. Abbot is not without his recreations. One detects that he finds it at times a struggle to ignore their siren voices and that in altered circumstances two of them at least, fly fishing and the growing of roses and sweet peas, might become real absorptions. Of his horticultural activities he is very modest. "I don't *grow* roses, I just put them in the ground and tend them." "But I do *grow* sweet peas!" What really appeals to him about both is their colour, first, and then their shape, "their architecture." In this he is willing to trace his early experience in Dyestuffs Division as a colourist. Colour is important to him, and shape. But when he has admired and cut his blooms, he is content to leave the arrangement of them, as elements of household decoration, to a hand he acknowledges to be more skilled than his own, that of Mrs. Abbot. "She makes *beautiful* arrangements!"

Fishing—for trout rather than salmon mostly—is a delight and a solace. But he insists that fishing is a selfish pastime—its very solitariness is, for an all too busy family man, a self-indulgence. Of golf, too, he is very fond. He finds that he makes more effort to find time for a round of golf than for a bout of fishing, "though I enjoy that more." Driving a car has little attraction for him in present conditions. "It's just another form of pressure."

"I am not," he will tell you, "a pattern man." And anon: "I'm a bit of a dropper-in." He feels that man-to-man confrontation is essential to genuine understanding, and he dislikes the formality of meetings. He likes to look in, to have a look round, a chat with whoever is about, and to hear what people are thinking. This is the very reverse of what he calls "snooping," and he regards it as part of a manager's proper function and a touchstone of mutual confidence. The obligation that he puts upon himself is that which he looks for in others—integrity. "If I'm an undivided man," he will say with an apologetic smile, "that is enough."

He is a man of great vigour of mind, wide interests, and a tolerance for human foibles where they are genuine and not mere affectations or camouflage for exploitation. Normally perhaps on the severe side in countenance, he smiles readily and gives no visible sign of tension. Challenged directly, he denies that he entertains any pet aversions. "But surely, Dr. Abbot, you must dislike *something* or other?" He reflects a moment: "Well, yes, I suppose I do. I suppose, if you insist, that I really do dislike—*dahlias!*"

WHAT'S BREWING?

by Wilfred Duffy

IN 1881 the number of licences issued for the production of beer for sale, as against brewing purely for private consumption, was 16,798. In 1963 this figure was only 304. Broadly speaking, however, in 1881 it was only the odd hundreds of licences that went to companies brewing on a large scale for sale to inns and taverns, while the remaining thousands went to innkeeper brewers whose brewhouse was on the premises to make beer for sale over their own bar.

Though the family brewery company still exists, generally the modern trend is one of mergers, whereby more and more individual breweries come under the umbrella of one controlling group. This trend, however, has advantages for the consumer because it extends the field of distribution and thus the choice of product in an area. With over 2,000 different beers in Britain today the choice is wide indeed.

Modernisation, though, extends outside the production unit itself and is evident in the "local," which is no longer the dingy beerhouse of Victorian times but a comfortable, attractive meeting place of both sexes and even families, where not only drink but food also is offered.

Brewing may be called an ancient art but a young science.

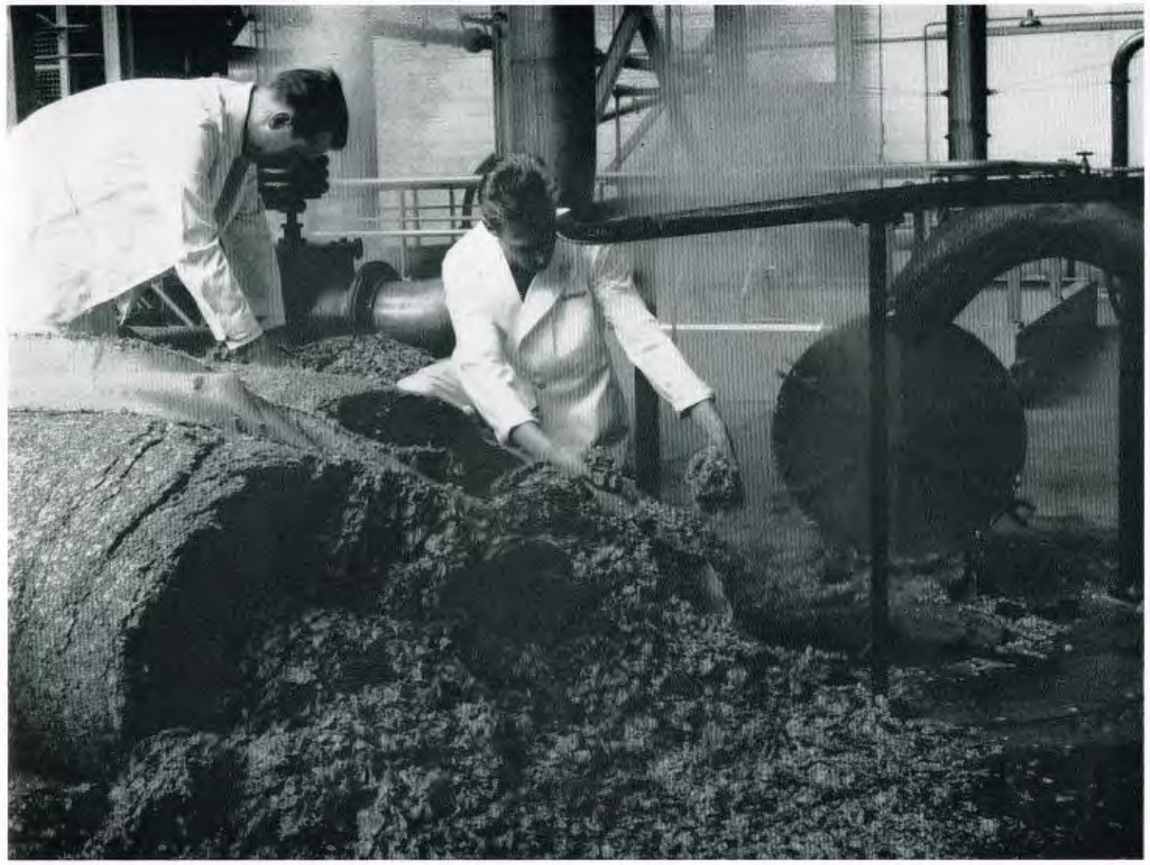
The truth of this is evident if one peers into the mists of antiquity enshrouding the beginnings of this industry. It is believed that the Egyptians, who it is known definitely brewed beer in the Fourth Dynasty, may well have learned the art of brewing from the peoples of the valleys of the Tigris and Euphrates, where beer is thought to have played an important part in domestic economy as early as 7000 B.C.

Though the basic ingredients in the "living" process—barley, hops, sugar, yeast and water—are variable in quality, each customer at the bar expects—demands, in fact—a consistency in his favourite beer that he would hardly expect even in his milk.

Harp Picture

The Fermenting Room at the Harp Lager Brewery, Alton, with stainless steel vessels

A typical 'fermenting room' of the past with its round and square wooden vessels. The pipes shown were the gas lighting mains



Arthur Guinness Son & Co Ltd.

English hops are grown mainly in Kent, Sussex, Worcestershire and Herefordshire. Apart from giving the beer its characteristic bitter flavour the resins also act as a preservative

No longer, therefore, the log-burning kiln fires of yesterday, the manual paddle-rousing in wooden vessels, the ladle for skimming off the surplus yeast, the hop valuation under northern light and a cloudless sky, but a mechanisation and quality control which today have entered every facet of malting and brewing.

The brewing process is basically one of mixing the malted barley with hot water, then straining and boiling the liquid extract with an addition of sugar and hops. After the spent hops—which are used as fertilizer—are extracted, the remaining wort is cooled and then dropped into large fermenting vessels. It is here that the yeast is added to convert the fermentable malt sugars into alcohol and carbon dioxide. This takes 3–6 days, after which time it is ready to be racked off into cask, or transferred to conditioning tanks for subsequent chilling, filtering and bottling.

The brewing industry uses something like $8\frac{1}{2}$ million cwt of barley a year for malting. Malting systems vary from the traditional "floor" malting, where the steeped barley is spread on the floor in layers and turned manually during germination, to the so-called Saladin and Domalt systems, where the barley is mechanically handled through all the malting process of cleaning, drying, steeping, malting and kilning, ready for grinding. In some maltings, too, the germination process is stimulated by the use of gibberellic acid, the first isolation of which was the result of the work of a team of biologists and chemists at the Akers Research Laboratories of ICI.

A young science indeed, when it is considered that it was not until 1863 that Louis Pasteur explained much of the mystery of fermentation, and that even then his explanation was not generally accepted.

Stainless steel is everywhere evident in the modern brewery, and 150 tons of it were used in one of the largest beer storage vathouses in Britain, at Guinness's Park Royal Brewery, where 24 steel vats each hold over 400,000 pints! Another two vats each hold 1,300,000 pints! Stainless steel does not affect the flavour of beer and is easily cleaned and thus lends itself to another innovation—the "in-place" cleaning unit, which sprays jets of detergent/bactericide all over the surface, thus eliminating the element of human error in manual cleaning.

The steel or steel lined cask is now used, and the keg or canister, with its chilled and filtered beer served under pressure from CO_2 cylinders, nestles in almost every "local" today. These, and

Wilfred Duffy

A party from ICI Heavy Organic Chemicals Division, Wilton, enjoying refreshments after a tour of Vaux & Associated Breweries Ltd., Sunderland

the advent of bulk delivery to, and bulk storage at, the licensed house is fast diminishing the ancient and interesting cooper's trade, though the wooden cask is still the main draught container at present.

One of the most interesting sights in a brewery from the mechanisation point of view is in the bottling department. A single filling unit may be able to handle about 30,000 half-pint bottles per hour. To watch the army of filled and crowned bottles parade up into and through the gleaming pasteuriser is fascinating indeed. So too is the operation of the Labeller, where the bottle itself pushes an arm which in turn allows the picker plates to select one neck and one body label, both being held in position by a grip finger until brushes mould them to the shape of the bottle. Finally automatic packers lift the requisite number of bottles and drop them neatly into their cases.

Wooden cases, like the wooden casks, are gradually being superseded; metal and plastics, including high density polythene, are used because they are lighter, take up less space and are less easily damaged.

Throughout the whole process of beer production, from barley to beer, a careful laboratory check is made. Every brew in cask or bottle that goes out to the public has its duplicate sample under continuous observation at the brewery.

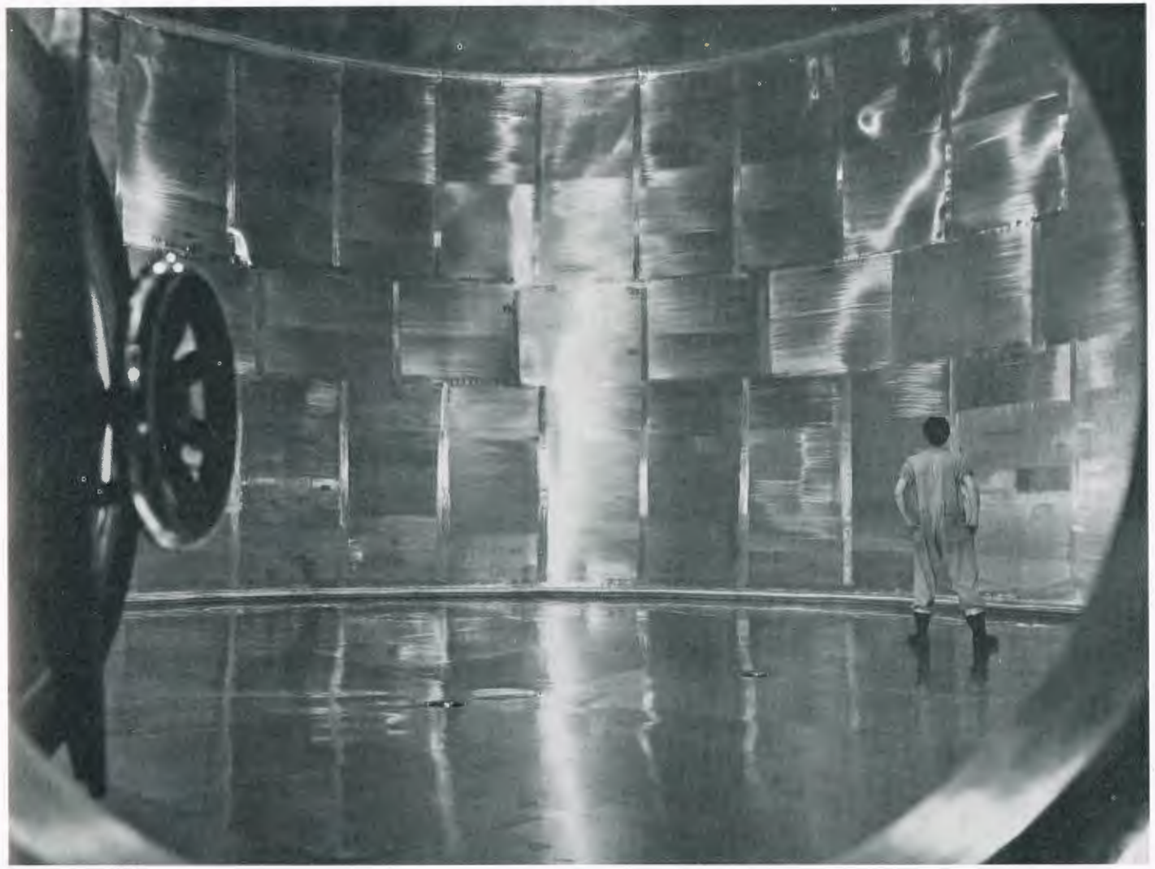
Although, like other industries, most breweries today have their own laboratories and chemists, it is to the Brewing Industry Research Foundation at Nutfield, Surrey, that they turn for the pure research. It is here that possible future innovations are tried and tested.

The industry provides a great source of revenue to the Exchequer. The duty on beer at the beginning of the century was only 7s. 9d. per standard barrel; in 1915 it was 23s., but 50 years later, in 1965, it rose to 353s. 3½d. per standard barrel.

The Chairman of the Brewers' Society has pointed out that beer drinkers in one month last year (June) contributed more than £1,000,000 *a day* in tax to the revenue. 1,842,012 standard barrels of beer were produced last June, easily the highest for any month since 1939, when the Society's records began. The standard barrel, by the way, is a hypothetical unit used for taxation purposes and is equal to 36 gallons of a strength obtainable by using two bushels of barley malt. The tax on it works out at nearly 1s. 3d. per pint, and something in the region of £326,000,000 has been estimated by the Chancellor for the full year's revenue.

ICI supplies a wide range of products to the industry. In breweries, where cleanliness is so important, ICI bactericides

Arthur Guinness Son & Co. Ltd.



1,300,000 pints or 4,500 barrels is the capacity of this stainless steel vessel at Guinness Park Royal Brewery

and detergents are used in the brewhouse and in fermentation, conditioning and bottling plants. The growth in the sale of keg and tank beers has led to an increasing demand for liquid carbon dioxide—some of it supplied by Agricultural Division from Billingham and Severnside—for top pressure dispensing of beer, for the purging of storage tanks and tankers and for beer movement.

Mond Division refrigerants used for keeping beer cool, special Paints Division lacquers for coating the inside of beer cans, caustic soda for cleaning—the list of ICI products can be said to cover every stage, from the growing of best malting barley with the aid of fertilizers to the washing of that emptied glass in the "local."

Vaux & Associated Breweries Ltd.

Filled and crowned bottles parade up and through the gleaming pasteuriser. Sprayed with hot water, the beer is gradually heated up to 140°F and maintained at this heat for 18 minutes. This ensures that the beer will keep in good condition

That 'FLEXEL' warmth

by Harry Hutchison

The 'Flexel' element and insulating blanket being laid between the rafters of a house being converted to the new space-heating system

A typical 'Flexel' installation in a Chelsea shop

TWO winters ago the tenants of two Saltcoats council houses started to share an enjoyable experiment in comfort. With the agreement of Saltcoats Town Council their homes were fitted with the new 'Flexel' space heating system invented in the Nobel laboratories at Ardeer some three miles away.

In all weathers since late autumn 1964 the tenants have lived in comfort despite the outdoors' winter and early spring mixture of frost, snow, hail or rain—such weather, indeed, as causes many men to wish they were equipped with better built-in thermostats so that they could adjust to the British climate. These tenants secured a cosy indoor climate for themselves merely by switching on the electricity in the rooms they wanted to use and adjusting the warmth by turning a thermostat beside the power switch on the wall with no more effort than is needed to tune in a radio to the right waveband.

They had comfort in every part of their 'Flexel' warmed room, without pipes, radiators to eat into floor space or fires that make housework. No magic established this situation. In their rooms the ceilings were large-area radiators beaming invisible warmth evenly downwards from the ceiling to the floor, and exposing every object, animate or inanimate, to the cosy influence. Creature comfort at 66°F is flattering to the senses, especially if it is secured by radiation and not partly by convection, which, by its nature, encourages airflow and draughts. So the Saltcoats tenants in their experimental homes found out, and they also discovered that although their electricity was not off-peak at a special price the consumption was more frugal in units and comparable in cost with the electricity bills of two homes, similar in all respects

A corner of the living-room in a Saltcoats flat.
The flat is heated by means of 'Flexel' placed immediately above the ceiling

save that they were equipped with under-floor off-peak tariff electricity.

No trouble was experienced with this pilot scheme, maintenance costs were nil. These and other factors were assessed by the Saltcoats authorities, who then gave 'Flexel' an important vote of confidence when they decided to install the system in a new development of sixty flats whose first block was completed early in January. Indeed, during the last week of January and the first week of February the Council opened one of the flats as a show-house furnished by the Ardrossan Co-operative Society. In less than a fortnight several thousand members of the public saw the showhouse and experienced the finger-tip control 'Flexel' warmth that pervaded the large living-room, the kitchenette, the hall and the three bedrooms. They enjoyed this warmth as much as the workmen who earlier had decorated the flat during some very severe weather. In this fortnight and for some weeks thereafter the flat was visited by representatives of other local authorities, builders and architects who were interested in the

system and wanted to see it in operation. Technical men from Nobel Division explained the theory and practice of 'Flexel.'

"How," you may ask, "how does Nobel Division find itself with an interest in the space-heating business?" Surprisingly, perhaps, the answer has its origins in silicones with their special properties, and research some years ago on the character of silicone rubbers. The properties of a cured rubber depend partly on the nature of the filler used. Among the fillers examined was carbon black, which did not increase the strength of the cured rubber but made it a conductor of electricity. Research men were not astonished, so the words "Eureka! Eureka!" were not even whispered at the time, although later there was some excitement.

When seeking the answers to one problem the technical man will note characteristics that are not immediately relevant, but in a new situation his mind will backtrack over past observations. So when new uses were being sought for silicones a much more complete examination was made of the electrical properties of carbon-filled silicone rubber. A thin layer of the carbon-filled silicone rubber in solvent was applied to a supporting cloth and subsequently cured. It was found that this formed an element that would conduct electricity in a highly reproducible way and that the entire surface of the element would attain and maintain warmth. It is from this observation and the many experiments that followed that the basic 'Flexel' element has been evolved. Silicone rubbers have a very long life, and besides defying attack from atmospheric conditions or moisture they resist comparatively high heat—as much as 150–200°C—indefinitely without deterioration.

Thus the basic silicone qualities were ideal for the intended electrical space-heating purpose. The heating element is a silicone conducting rubber supported on a glass-cloth base material. Along the long parallel edges of the material strips of copper foil are stitched. When electric current is passed through these copper electrodes the entire surface of the 'Flexel' warms to an even temperature all over and the heat is easily maintained at a predetermined level. The coated element with its electrodes is insulated in a thin impervious 'Melinex' envelope. The sheathed material is supplied in any length and in widths that range from as little as 6 in. to 48 in. The sheeted element is cut to the precise lengths needed and laid between rafters against the upper side of a plasterboard ceiling, or affixed to the underside of rafters before the ceiling board is put in position during house construction. It is also easily installed during the building of concrete-floored blocks of flats. A light 2 in. thick blanket of insulating material is laid over the upper side of the 'Flexel.'

When the electrical connections are made and the installation is complete there is no visible evidence of the space-heating system save the small electrical switch and the thermostat in each room. In any completed house where the ceilings are of plasterboard and there is free access to the rafters 'Flexel' can be fitted without trouble or structural alteration, and, of course, when a new house is to be space heated with the 'Flexel' ceiling heating system there is no need to build chimneys or fireplaces, and economies result. Fitting during construction is even simpler than with an already built house.

The precise pattern of installation is calculated in relation to the room that has to be heated, and the electrical loading is fixed to give the desired and controllable temperature range for maximum comfort. To ensure that the system is tailored for each house Nobel Division has appointed agents who, trained in the technicalities, are responsible for installation.

In warm spring, summer and autumn days the 'Flexel' is idle, but is there to be switched on should there be a chill in the evening or cool winds blow. Indeed, this easy provision of heat only when heat is needed is an outstanding 'Flexel' advantage. All parts of a room are equally warm, so there is no domestic struggle in winter to secure the hot spots which, anyway, don't usually give the subject warmth back and front and round about. Warmth quickly established following the switch-on of current is particularly attractive for buildings such as libraries, clinics and church halls, which are used intermittently.

Although I have referred only to the Saltcoats development, 'Flexel' heating can be, and is being, effectively applied to all types of modern buildings throughout the country. Offices, factory buildings, halls, shops and supermarkets can be effectively space heated by the 'Flexel' system, and week by week the number of buildings so equipped increases as does the volume of interest shown by builders and architects.

The first block in a Saltcoats development of 60 flats completed in January. These flats are heated by the 'Flexel' system, and thousands of people visited the showhouse when opened to the public

BRITAIN'S WATER SUPPLY

by J. A. Cooper

Teesdale: the Meeting of the Waters

Water is a controversial subject at the present time to many people in Great Britain. Despite our climate, the British are slowly becoming aware that water is a precious commodity, forming one of the country's few natural resources, and that even in Britain there is not an inexhaustible supply. Much has been made in recent years of water shortages in Kuwait, Hong Kong and other parts of the world where the water supply has to be supplemented in some cases by the "water from the sea" process, i.e. desalination. Is there a water shortage in Great Britain? Who needs water? Do reservoirs under modern conditions despoil nature? Is desalination a panacea for water shortages? Are estuarial barrages practicable? These are some of the problems to which the public want answers.

Perhaps the first thing to say is that water is naturally abundant in the United Kingdom. With an average yearly rainfall of 36 in., all the water if collected would amount to many times the average usage of 40 gallons per head of potable water per day. Even after allowing for evaporation and ground losses, there is still a vast surplus which runs to waste into the sea. Why then is there any difficulty about water supplies? Why don't engineers do their usual miracles and make the naturally copious supplies of water available to the community?

Two principal difficulties arise. First, the main sources of water are usually in the hilly and more remote parts of the country, such as Wales, the Lake District, the Pennines and Scotland, whereas the more heavily populated parts of the country, such as London and the Home Counties, are in the drier areas. Secondly, the reservoirs are usually set in the more attractive and mountainous parts of the country, many of which are National Parks. Emotions are readily aroused when any suggestion is made to encroach on the National Parks with any utilitarian object, particularly of a semi-industrial character such as a reservoir. Is this justified? The newly formed Water Resources Board, whose duty, nationally, it is to safeguard and extend future water supplies, had this to say in a recent annual report: "The total area of the Parks covers too much of the country—some 10%—to be regarded as sacrosanct from any change."

The Water Resources Board also reported that the total demand for water in Britain by the year 2000 is likely to be 10,000 million gallons a day. Although the demand is very large, it must be remembered that much of the water is used more than once. On any large river, water from towns in the higher reaches discharges back into the river in a less pure condition and is treated and re-used by the next town downstream, usually after flowing down sufficient length of river to be improved by natural means. Again, power stations, for example on the Trent, take in cooling water in vast quantities and discharge it back into the river. In both these examples the water is available for re-use. If, however, water is circulated in cooling towers and lost by evaporation or discharged into salty estuaries or the sea, it is clearly of no further use to the community as a source of fresh water.

It may be helpful to consider some of the modern methods of producing water—at a cost—of which desalination is far the most important. In desalination processes, of which the multi-stage flash evaporator is the most popular, fuel is used to produce steam to operate a highly efficient distillation plant to

produce fresh water from the sea. The capacity of the largest desalination plant at present in operation is 1·5–2 million gallons a day, and the next stage of development is expected to be 5–10 mgd. The cost of water from such plants is upwards of 10s. per 1,000 gallons—expensive compared with the current cost of obtaining water from conventional sources at 2s. to 3s. per 1,000 gallons. These plants could be made much larger with technological progress, and if their capacity could be raised to 25–30 mgd, and associated with nuclear power, the cost might be brought down to perhaps 4s. per 1,000 gallons. Clearly there is promise in desalination proposals—even now for small plants in occasionally dry areas like Guernsey. However, large-scale applications are 12–15 years off and are therefore not much use in making water available in the next five to ten years.

How does all this affect the Company, which is always concerned about its future water supplies to safeguard production at its many works? A current example is on Tees-side, where the Company's factories at Billingham, Wilton and the North Tees site have increased their consumption of clean water from the Tees Valley and Cleveland Water Board from 4 mgd in 1949 to an estimated 50 mgd in 1970. The implications of a water shortage were first realised on Tees-side after a drought in 1949, and arrangements were made by the Water Board to construct the Seelset reservoir by 1960. ICI' total requirments at that time was 8 mgd. Before 1960, however, it was necessary

Pumping station at Worsall

to start another reservoir (Balderhead) to bring the supply to ICI up to 25 mgd by 1965. With Balderhead completed in 1965, negotiations are under way to increase the supply to ICI to 50 mgd by 1970. The 1959 drought, which nearly closed down the Tees-side factories, dramatically illustrated the danger of delay in the provision of additional water supplies.

Why does the Company need these vastly increased quantities of water, and could this need have been foreseen earlier? The increases are largely associated with the development of the Agricultural Division's revolutionary steam reforming process for town gas production and fertilizer manufacture, and the phenomenal increase of man-made fibre production on Tees-side. The rate of development of either of these processes could hardly have been foreseen four or five years ago. These and many other ICI Tees-side products contribute in no small way to Britain's exports and the balance of payments problem.

The above expansion has been associated with the development of the North Tees refinery—soon to reach an output of 5 million tons of oil products per annum. In the modern petrochemical industry, of which ICI on Tees-side is now a notable example, oil consumption means water consumption—for water is the one raw material which is used in practically every major chemical process.

When the Company realised the magnitude of the forthcoming expansion on Tees-side during the five years to 1970 it approached the Tees Valley and Cleveland Water Board with a request for a further increase in supply of 25 mgd by 1970, i.e. a total demand of 50 mgd. The Water Board had long become used to the tempo of expansion in the North East and with their customary vision embarked on further plans for a reservoir of some 35 mgd of reliable yield, bringing the total output of their undertaking up to 100 mgd by 1970, to make them one of the giants of the water industry in this country.

Their consultants reviewed a large number of possibilities and finally decided on a site, excellent from a technical standpoint, at Cow Green in the desolate valley of the Upper Tees. A reservoir at this site would cost £2·4m. Agriculture at Cow Green was limited to sheep grazing, minerals were no longer mined, and there was no outstanding natural beauty, apart from the valley itself which had the appeal of solitude. Nearby were two famous waterfalls, Caldron Snout and High Force. Since it was intended that all the water from the reservoir would flow down the Tees for abstraction lower down, which would increase the summer flow in the river to the benefit of the falls as well as to angling and farming, it could be claimed that the plan would confer benefits on all interested sections of the public.

It has, however, been known for at least a century that Upper Teesdale is a botanical "museum" containing many species of rare flora. In general, however, few of these flora are rare in an absolute sense, but as a collection of unusual species brought together in one area they are of great interest —the overworked word "unique" is perhaps best avoided in this connection; there are other interesting areas in the British Isles, e.g. the Burren district of Ireland, the Brecklands of East Anglia and Ben Lawers in Scotland.

Many people on hearing of a botanical paradise visualise the equivalent of "a host of golden daffodils," but this is a mistaken view of Upper Teesdale's botanical treasures. These are mostly minute flowers, some of them brilliant in appearance but nearly all likely to be overlooked except by the knowledgeable. The latter are attracted every spring and summer by the appearance of such species as Gentiana verna (spring gentian), Viola rupestris (Teesdale violet), Primula farinosa (bird's eye primrose), potentilla fruticosa (shrubby cinquefoil) and many others. Some of these are relatively widely spread over the dale and others grow in isolated communities.

Botanists are deeply interested by this assembly in the dale of plants of the rarer types—it might be necessary to go to the Alps or Scandinavia or a variety of other places to find other individual examples—and they are pursuing botanical and ecological research to discover the flowers' evolutionary secrets. The plants are believed in some cases to represent survivals from the Ice Age.

What dangers are likely to arise from the making of a reservoir? There are at least four major areas of botanical interest in Upper Teesdale, from Winch Bridge to High Force, Dineholm,

The Tees at Low Force

Cronkley Fell and Widdybank Fell, amounting in total to some 5,000 acres of the upper part of the dale. The reservoir, which will have an area of about 700 acres, abuts on one side of Widdybank Fell and would inundate an area of about 20 acres of special botanical interest. The botanists say that these 20 acres contain one of the more interesting communities of flowers in the dale. There are many other interesting communities in the dale, but each in its own location is of course unique. Indirect disadvantages of the reservoir, which are cited, are possible micro-climate changes, alterations in water table levels and so on.

What is the Company's attitude? When a similar proposal arose in 1959 to flood Dineholm, the best local site for a reservoir, the Company concurred in the Water Board's eventual alternative proposal to put the reservoir in the Balder valley, where are located some of the Board's other reservoirs. This alternative site avoided flooding the whole of the Dineholm area with its complete collection of flora. This time also alternatives to Cow Green have been considered. But other sites would in general cost much more, would take 2–3 years longer to construct, and most would have a significantly lower reliable yield. The delay might well jeopardise the Company's plans for production and exports in the early 1970s. The Company has therefore supported the Cow Green scheme and has offered to finance a research programme on the 20 acres of special botanical interest and also to finance the provision of a warden, during construction, to ensure that no damage would be done to Widdybank Fell above top water level. It has carried out micro-climate studies on the Fell and experts have been consulted on the question of water table levels, etc., and the Company believes that these are of negligible danger to botany.

Continued on page 57

IN SEARCH OF THE BADGER

by Peter Bond

The badger is a much-maligned and misunderstood member of our fauna. The fact that he has been on the increase over the past 10–20 years is probably a reflection of a decrease in persecution. Formerly badger digging and baiting were common pastimes, but now, fortunately, baiting has almost died out and digging is less widespread. Ignorance and stupidity die hard, but it is to be hoped that in these times, when conservation is fashionable, people will come to appreciate the badger as the useful animal that he is. Many sins are laid at his door, and poultry stealing is probably the most common. Careful enquiries have established that in almost every case where a badger has been blamed, the fox is the real culprit. The fox is often an unwelcome guest in the sett and, unlike the tidy badger, will leave pieces of his evening meal strewn around outside. A glance at the badger's menu will speak for itself: animal food includes young rabbits, rats, mice, slugs, bees, wasps, beetles and worms, and in the vegetable line acorns, beechnuts, bluebell bulbs and grass. Such a list is surely convincing evidence of the usefulness of the badger.

My first glimpse of a badger was hardly exciting or spectacular. On this occasion I had taken my camera to try for photographs. I waited motionless for over an hour until the dark shapes of the trees merged into blackness and my straining eyes began to imagine moving shapes. At last I sensed that there was something in the darkness, a flickering white shape. I pressed the camera shutter, there was a blinding flash, and the evening's watch ended abruptly. Some weeks later, with the return of my film, I knew that I had really seen my first badger. Since then I have watched badgers many times and under many circumstances. I have had many fruitless nights, but these are soon forgotten as I plan my next trip.

The badger has been my passport to a new and exciting land. As darkness falls, the world of light and colour sleeps and there stirs the many creatures whose life is governed by sound and scent. Alone in the darkness, the badger watcher soon realises how important is his sense of hearing. He must interpret the many strange sounds, the mouse among the leaves, the hedgehog rooting under the bushes or the owl snoring in the tree. The unexpected is always happening. One evening while watching what was thought to be a badger sett there emerged a delightful little fox cub. In the light of a red torch (most animals are relatively insensitive to red light) it could be seen perfectly as it sat unconcerned for several minutes before wandering off. Another evening, while watching in the darkness of a dense larch wood, a large tawny owl landed with a flurry of feathers not two yards away and sat staring at us, looking very ruffled. It was a very unnerving experience, and it was quite a relief when, after what seemed a very long time, our visitor flew away. Still, I suppose we can't grumble about being watched ourselves!

Badger watching is very much an adventure, and like every adventure it is not all pleasure. The watcher is a sitting target for the swarms of midges which seem to congregate round badger setts—I get through quite a lot of insect repellent in a year! Watching can be very cold in autumn and winter. One night, after watching for two hours in a temperature below freezing, the cold had so penetrated my clothes that it was some minutes before I could stand up straight. But such hardships are but a small price to pay for the privilege of the company of the badger.

There are more badgers than people think. I know of fifty active setts within a relatively short distance of my former home. When the signs are recognised, the badger is seen to cover almost all suitable ground. The paths which radiate from the sett may often be followed for distances up to almost a mile. Unlike man-made paths, they pass under fallen trees and low-growing bushes, and where a log has to be climbed over the marks of the stout claws can be seen. The badger is very much a creature of habit. As it noses its way from the sett it will always use the same well-worn tracks, and the degree of wear on a particular path is an indication of the importance of the activity that is associated with it. One sett, which is situated at over 1000 feet on a bare hillside, where the winds sweep unimpeded from the plains, has one very well trodden path. Follow this for a hundred yards up the steep hillside and you arrive at a gorse bush under which are many small scrapings. This is the badger's toilet. He is a clean animal and, unlike the fox, rarely fouls his sett. When he emerges from his snug home on a bitter winter's night and hurries up the well-trodden path, how he must sigh when he reaches the welcome shelter of the gorse bush!

It is frequently said that the badger hibernates. This idea is quickly dispelled. On a cold winter's morning, when a blanket of crisp snow covers trees and ground, the tracks of the badger betray the activities of the previous night.

There is no rule governing the location of a sett. One I know is situated at over 1300 feet, far away from water and the nearest trees, while yet another is in a river bank, below 400 feet and only 4 feet from water. Between these extremes are setts in all manner of situations. The only common factor is the choice of sloping ground, where a horizontal tunnel is soon far below the surface. This is a necessary precaution, as the badger's one real enemy—man—could easily dig down to a shallow sett. Several setts where I have spent many happy hours have recently been dug out and the badgers killed. There is no law against this practice yet.

Perhaps the most fascinating finding to emerge from my search for setts is the extreme regularity of their distribution. Most are just over half a mile apart, and only in very few instances are they placed nearer than this. This may mean that the badger is a territorial animal, but it would seem more likely that setts are dug out a reasonable distance from neighbouring ones so that each sett has around it an area able to satisfy the needs of its occupants. However, its nightly wandering, which it is said may be as much as three miles, the badger will often stray out of the area surrounding the sett. I have followed well-marked paths for considerable distances, during which they cross the areas bounding several other setts. This is not really surprising, as the badger is very sociable and at certain times of the year several families may live together, while visits to neighbours appear to be quite common. One of the greatest thrills of badger watching is to see such a group. The darkness draws in, the first call of the owl ripples across the valley and the woodcock flits across the western sky, then as the watcher holds his breath in expectation the first flash of white is seen in the dark sett entrance. The long snout held erect waves to and fro, then satisfied that the outside world holds no danger, the boar moves quickly out. Another head appears and a second badger emerges, then a third, a fourth . . . a fifth . . . How well you remember such moments!

Perhaps you would like to share my experiences of a fine June evening this year. The car is parked on a quiet lane near a farm. Midge repellent is applied lavishly. A friendly word is exchanged with the farmer. Luckily he is a person who welcomes the badger on his land. The evening sun, low in the sky, sheds an orange glow as we cross the fields towards the wooded valley in which the badger has made its sett. We are now about a hundred yards away, and we carefully note the way of the wind. The badger's nose is probably its most reliable detector of danger, so that this observation is of critical importance. We make a wide detour and approach up the valley, a dark canopy of trees behind us. Our precautions are justified: it is only half-past eight, but already the badgers are out. Can we approach without being seen? The four cubs are in a boisterous mood and they chase one another among the trees. The sow is sitting quietly on the mound of red earth that marks the sett entrance. She occasionally lifts her snout, scenting the air for any sign of danger. She scratches her neck vigorously with her hind leg, then leaning back she gently scratches her stomach—those fleas move quickly! Presently she ambles off down the side of the valley. We move closer inch by inch until finally we are ten yards from the sett. A rustling down the bank announces the return of the sow.

The cubs, ever curious, rush forward. It's only their mother, so back to their play. Hello, what is she doing? She is coming backwards in a series of bounds. As she approaches we see that she is dragging a large heap of dried grass for bedding. She disappears down the hole. Obviously this is the time for household chores. During the evening she made three such journeys. There is a sudden yelping, three of the cubs have got the other one on its back against a tree, they are playfully biting it. It finally escapes and all four chase madly round again. The cubs finally disappear down the bank—we can hear them snuffling as they root about for food. The sow, her jobs completed, sits at the sett entrance. Presently she rolls up and goes to sleep. A cow wheezes noisily; she is up in an instant, then, apparently satisfied, she dozes off again. At length she too ambles down the bank to join the cubs and we steal silently away, feeling well satisfied with our evening.

Badgers cautiously emerging on a night in August. Photographed by the author

Four badgers soon after emergence. Photographed at 11 p.m. by C. Dakin

PARIS 1966. *Model by Capucci in 'Crimplene' Jersey*